Dietary Reference Intakes---What's New and How to Use Them

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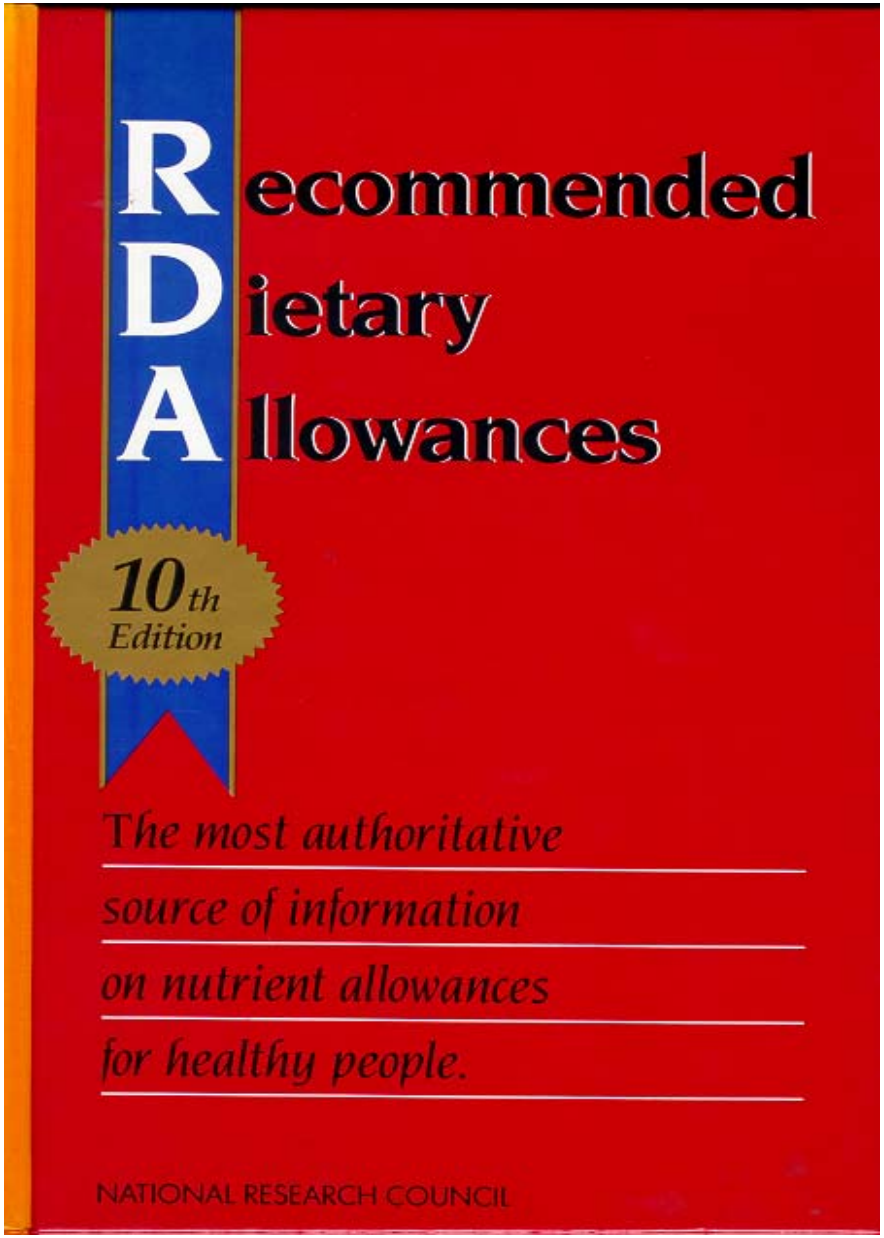
Recommended Dietary Allowances 1941

- Energy
- Protein
- 2 minerals (Ca, Fe)
- 6 vitamins (A, C, D, thiamin, riboflavin, niacin)


Recommended
Dietary
Allowances
10th Edition
The most authoritative source of information on nutrient allowances for healthy people.
NATIONAL RESEARCH COUNCIL

Recommended Dietary Allowances 1989

- Energy
- Protein
- 7 minerals (Ca, Fe, P, Mg, Zn, I, Se)
- 11 vitamins (A, C, D, thiamin, riboflavin, niacin, E, K, B_6, B_{12}, folate)
- Safe and adequate daily dietary intakes (biotin, pantothenate, Cu, Mn, F, Cr, Mo)

Examples of Applications of RDAs

USERS:

- Government - Industry - Academia - Health Services

USES:

- Guide for procuring food supplies for groups of healthy persons
- Basis for planning meals for groups
- Reference point for evaluating the dietary intake of population subgroups
- Component of food and nutrition education programs
- Reference point for the nutrition labeling of food and dietary supplements

DIET AND HEALTH

Implications for Reducing Chronic Disease Risk

NATIONAL RESEARCH COUNCIL

Dietary Guidelines Versus RDAs

- Dietary Guidelines
  Qualitative advice to the public about diet and chronic disease prevention and maintaining health

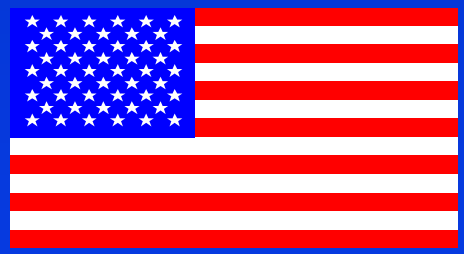
- RDAs (or AIs)
  Quantitative advice to professionals about amounts of nutrients or food components found to be of benefit

FNB 1994 Concept Paper

Focused on Need to Include

- Recommendations to meet variety of uses
- Concepts of reduction of risk to chronic disease
- Review of other food components
- Rationale for functional end points used
- Open dialog with interested groups
- Estimates of upper limits of intakes

DRIs



Dietary Reference Intakes

Food and Nutrition Board

Dietary Reference Intakes (DRIs)

Funding has been provided by Health Canada, the U.S. Departments of Health and Human Services (Office of Disease Prevention and Health Promotion, Food and Drug Administration, Centers for Disease Control and Prevention, and National Institutes of Health) and of Agriculture, the U.S. Army; the Dannon Institute; the International Life Sciences Institute-North America; and the DRI Corporate Donors' Fund (contributors include Kemin Foods; M&M/Mars; Mead Johnson Nutritionals; Nabisco Foods Group; Roche Vitamins; and Others).

Top 10 DRI Questions

1. What's wrong with the old RDAs? Can't you just update the numbers?
2. Is DRI the new term for RDA?
3. What's the difference between an RDA and an AI?

Top 10 DRI Questions

4. Why are some of the ULs less than the new RDAs for the same nutrients?
5. Why aren't they released all at once?
6. Why were DFEs developed, and why were REs changed to RAEs?

Top 10 DRI Questions

7. Should I be concerned that the current DV used for the food label for zinc (15 mg) is more than the new RDA for adults (11 mg), and more than the UL for children 1-3 years (7 mg)?
8. When are you (FNB) going to change the DV on the label?
9. Which DRI should I use to plan diets with?

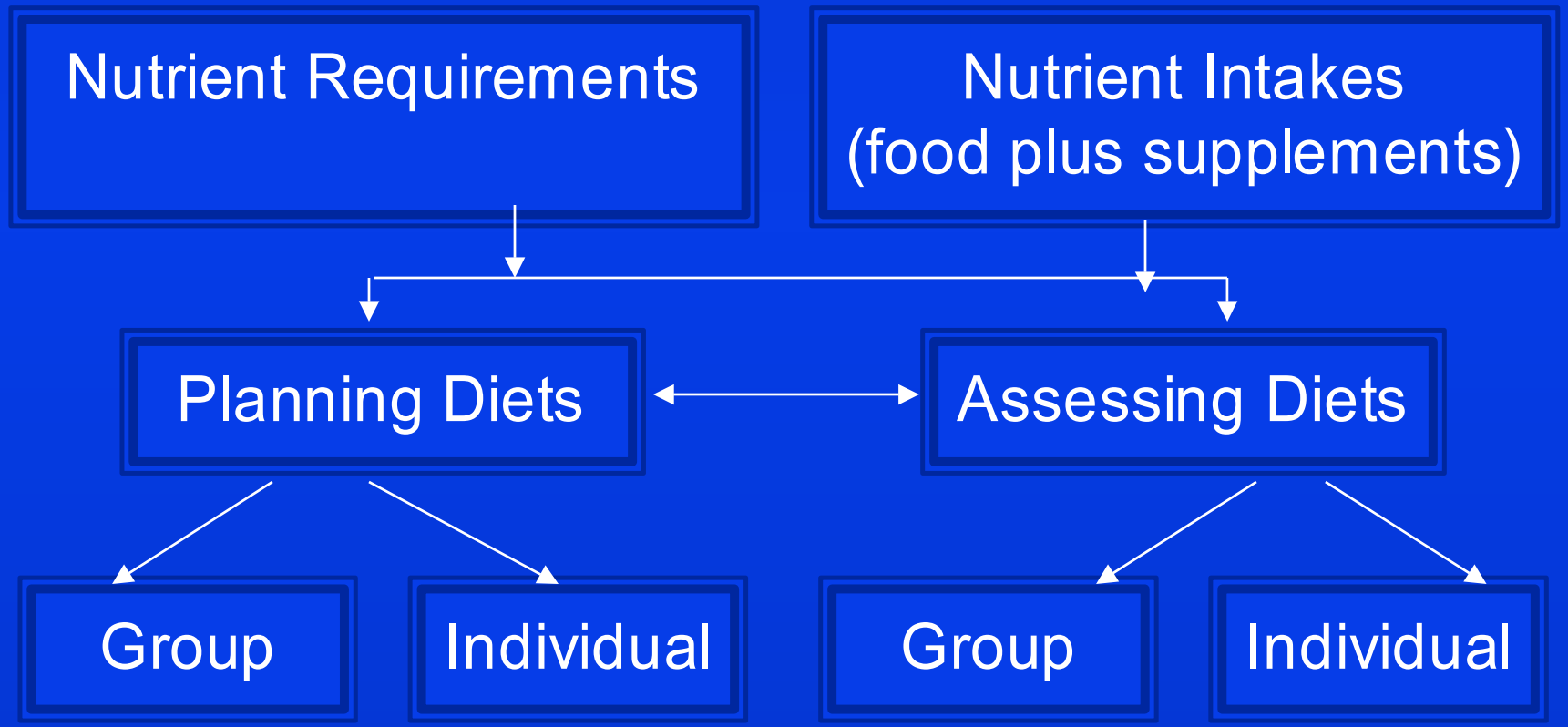
Top 10 DRI Questions

10. What do we do when you haven't given new recommended intakes for some nutrients such as sodium?

Why DRIs?
Conceptual Approach

- Quantitative dietary recommendations need to address multiple users and meet multiple needs
  - Labeling
  - Limits for fortification
  - Assessing adequacy of diets of population groups
- One number can't do it all

An Overview of the Uses of DRIs

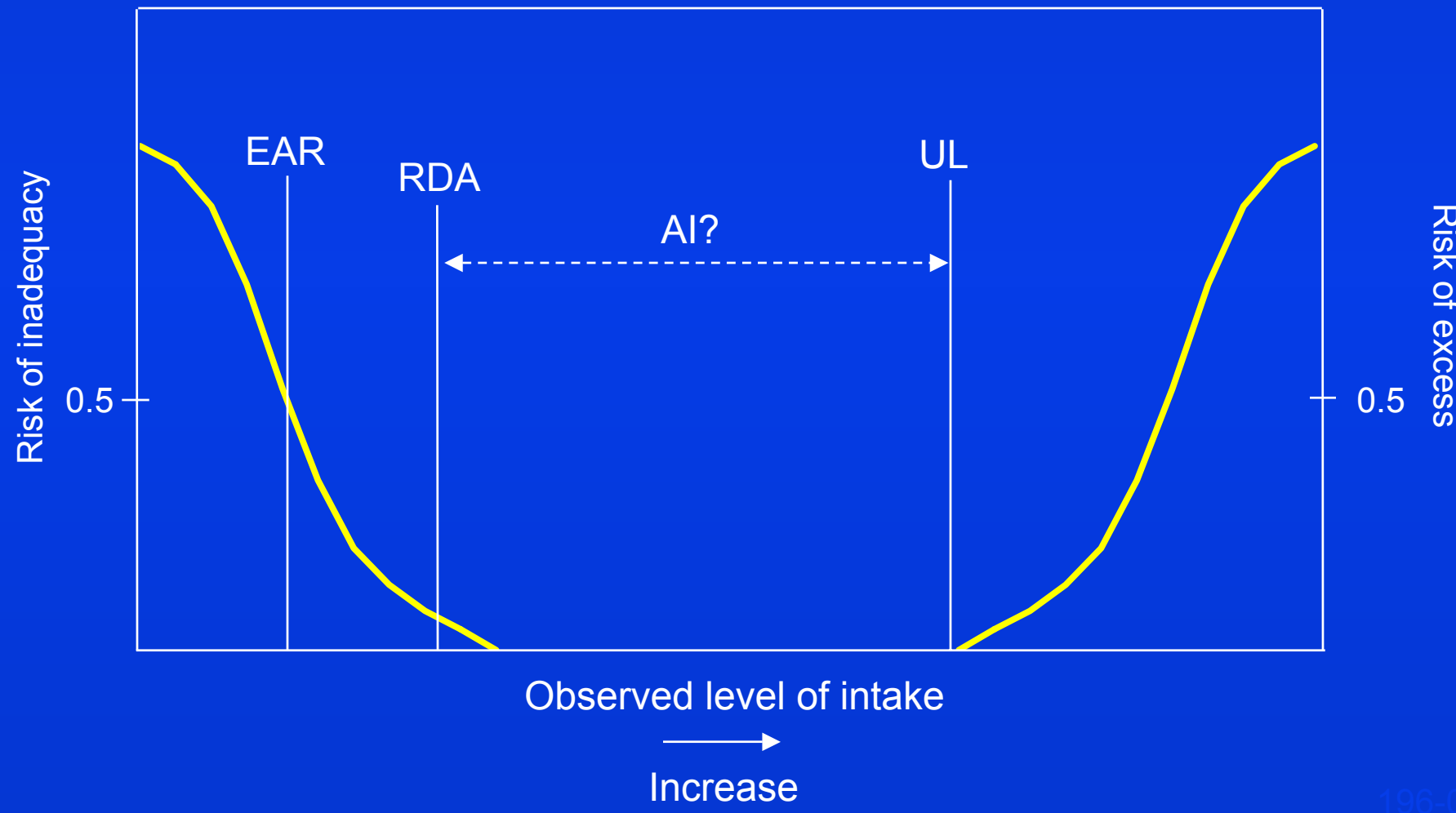


Dietary Reference Intakes (DRIs)

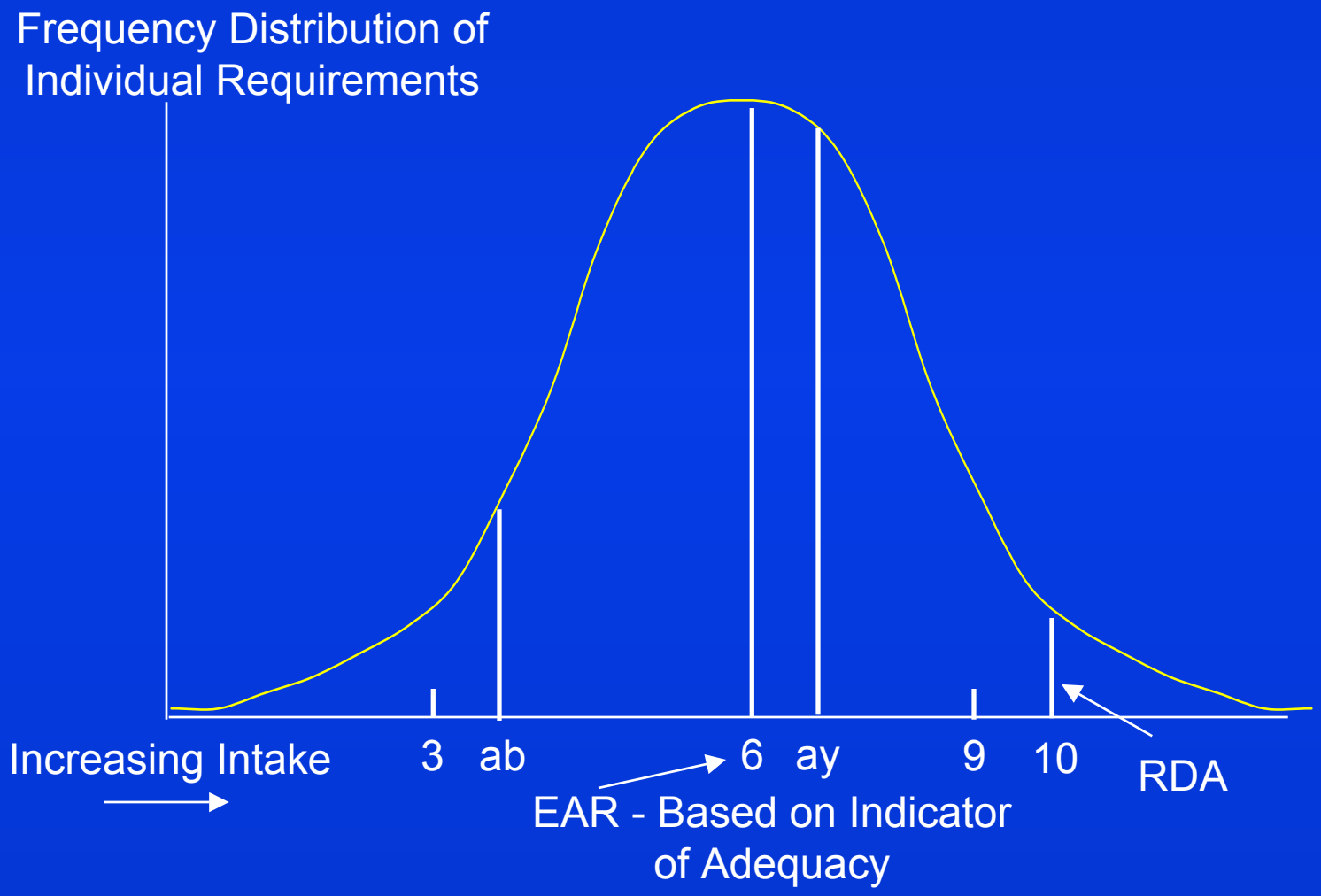
DRI is a collective term that includes nutrient-based dietary reference values:

- Estimated Average Requirement (EAR)
- Recommended Dietary Allowance (RDA)
- Adequate Intake (AI)
- Tolerable Upper Intake Level (UL)

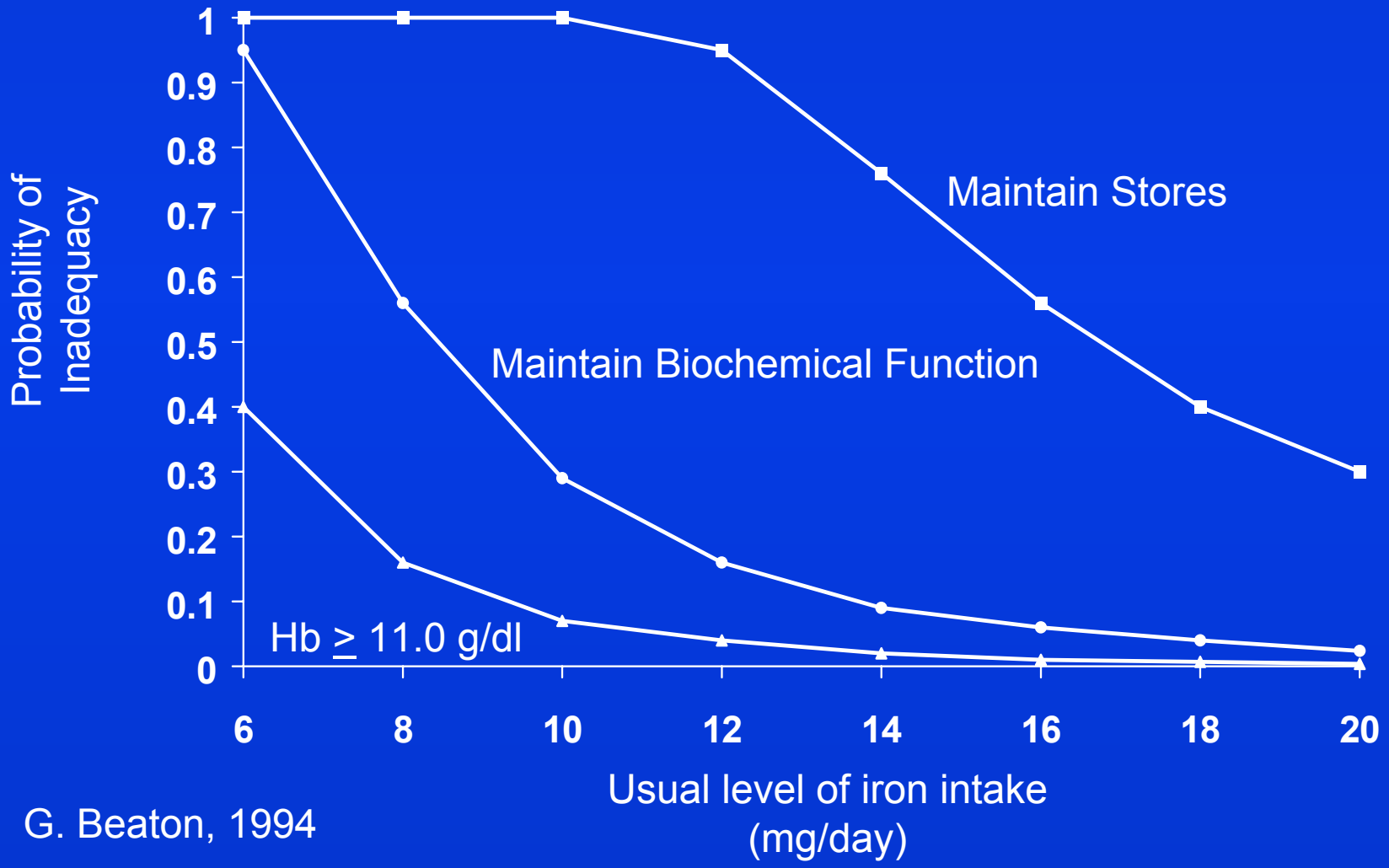
Dietary Reference Intakes



Model for Dietary Reference Values



Probability That Specified Usual Iron Intake Would Be Inadequate to Meet the Needs of a Randomly Selected Menstruating Woman[1]



G. Beaton, 1994

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Definition of RDAs

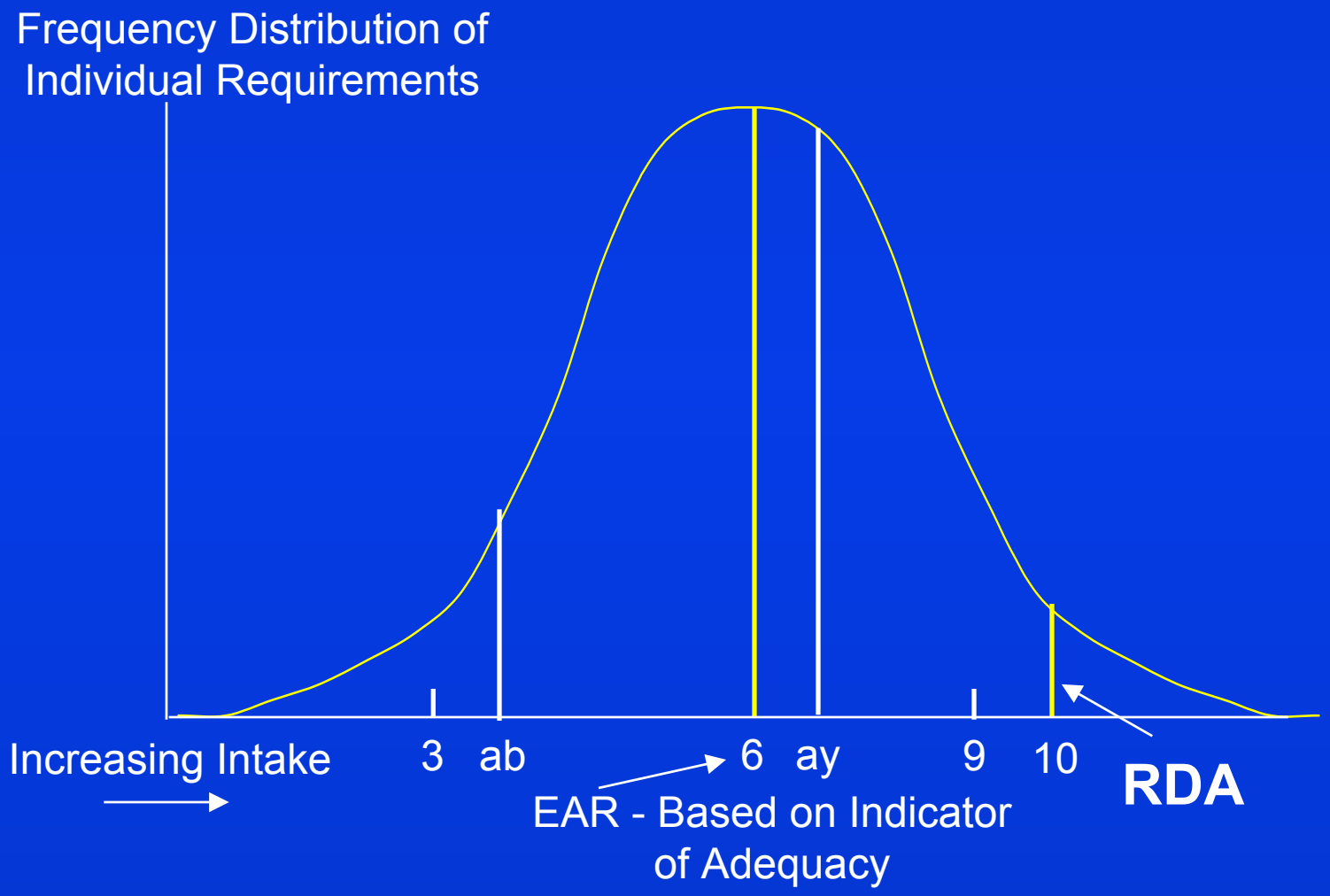
". . . levels of intake of essential nutrients considered, in the judgment of the Food and Nutrition Board on the basis of available scientific knowledge, to be adequate to meet the known nutritional needs of practically all healthy persons."

NRC, 1974, 1980, 1989

Dietary Reference Intakes (DRIs)

- Estimated Average Requirement (EAR)
- **Recommended Dietary Allowance (RDA**
- Adequate Intake (AI)
- Tolerable Upper Intake Level (UL)

Model for Dietary Reference Values



Relationship of EAR and RDA

- Estimated Average Requirement (EAR) = requirement for 50% of the population

- Recommended Dietary Allowance (RDA) = requirement for 97.5% of the population, so plan diets for individuals using this DRI

RDA = EAR + 2 SD

(if symmetrically distributed)

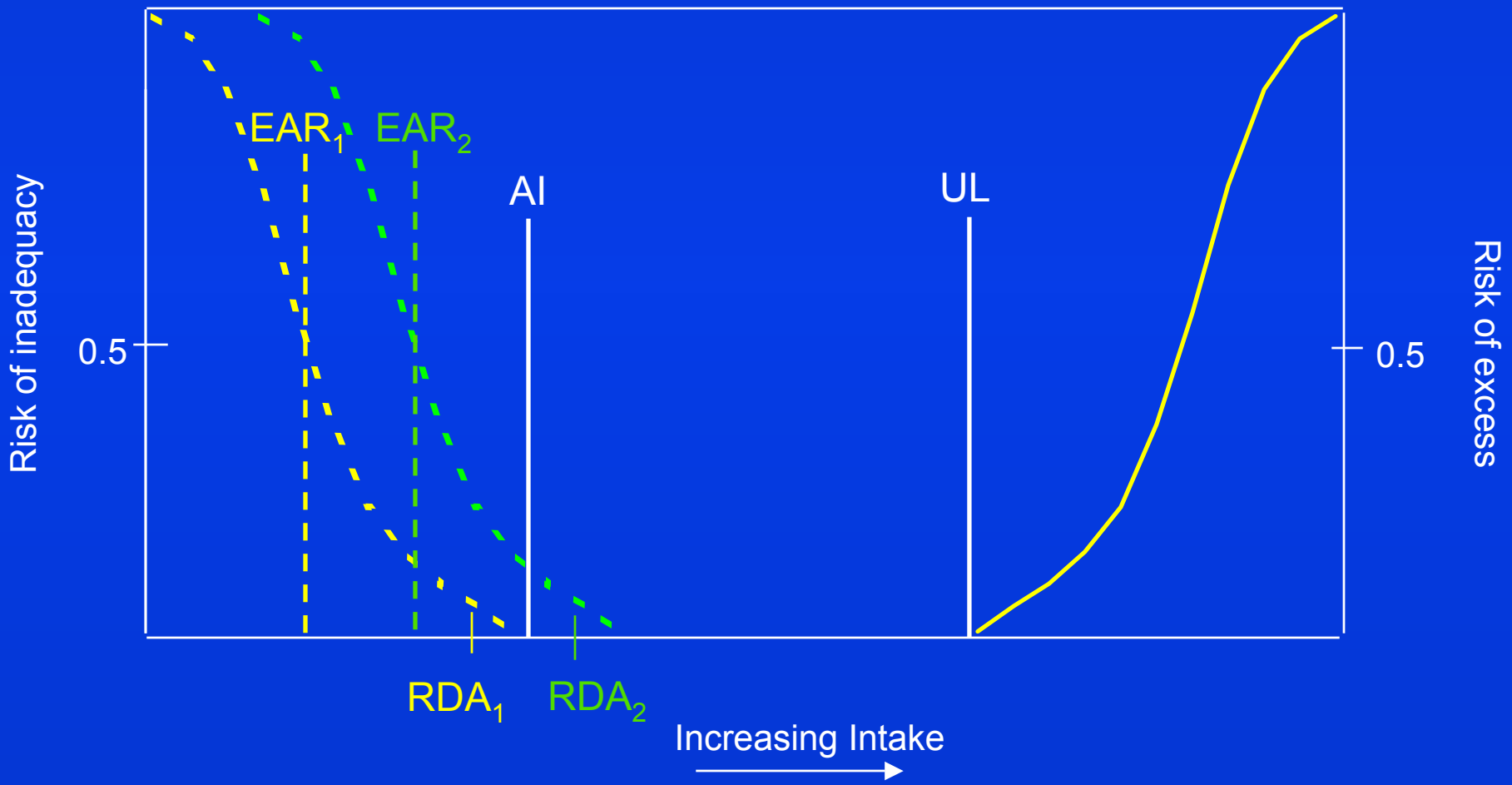
Dietary Reference Intakes (DRIs)

- Estimated Average Requirement (EAR)
- Recommended Dietary Allowance (RDA)
- **Adequate Intake (AI)**
- Tolerable Upper Intake Level (UL)

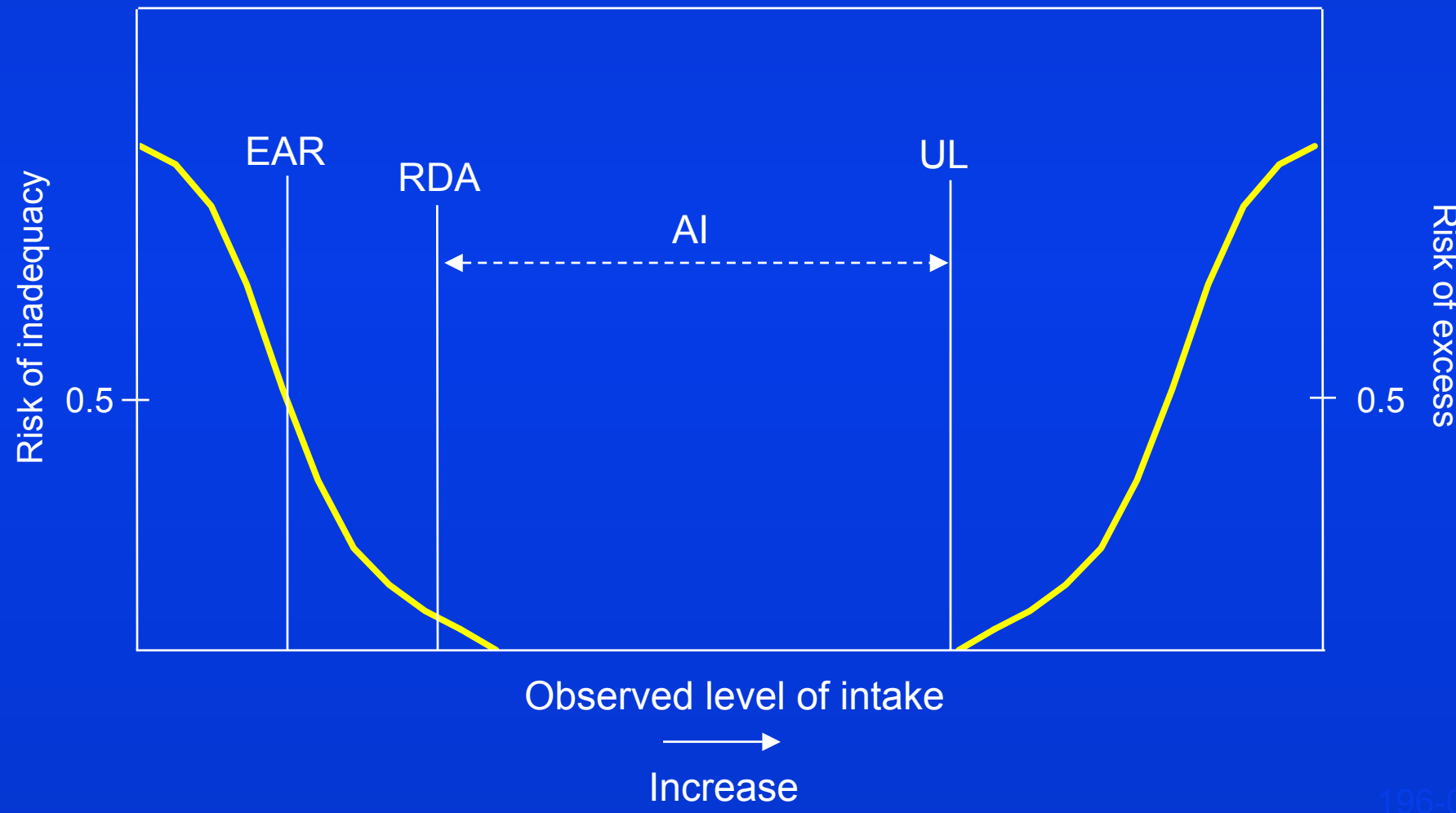
AI
Adequate Intake

- Based on observed or experimentally determined approximations of the nutrient intake by a defined population or subgroup that appear to sustain a defined nutritional state
- Used as a guide to nutrient intake for the individual

Relationship of AI to EAR and RDA



Dietary Reference Intakes



Dietary Reference Intakes (DRIs)

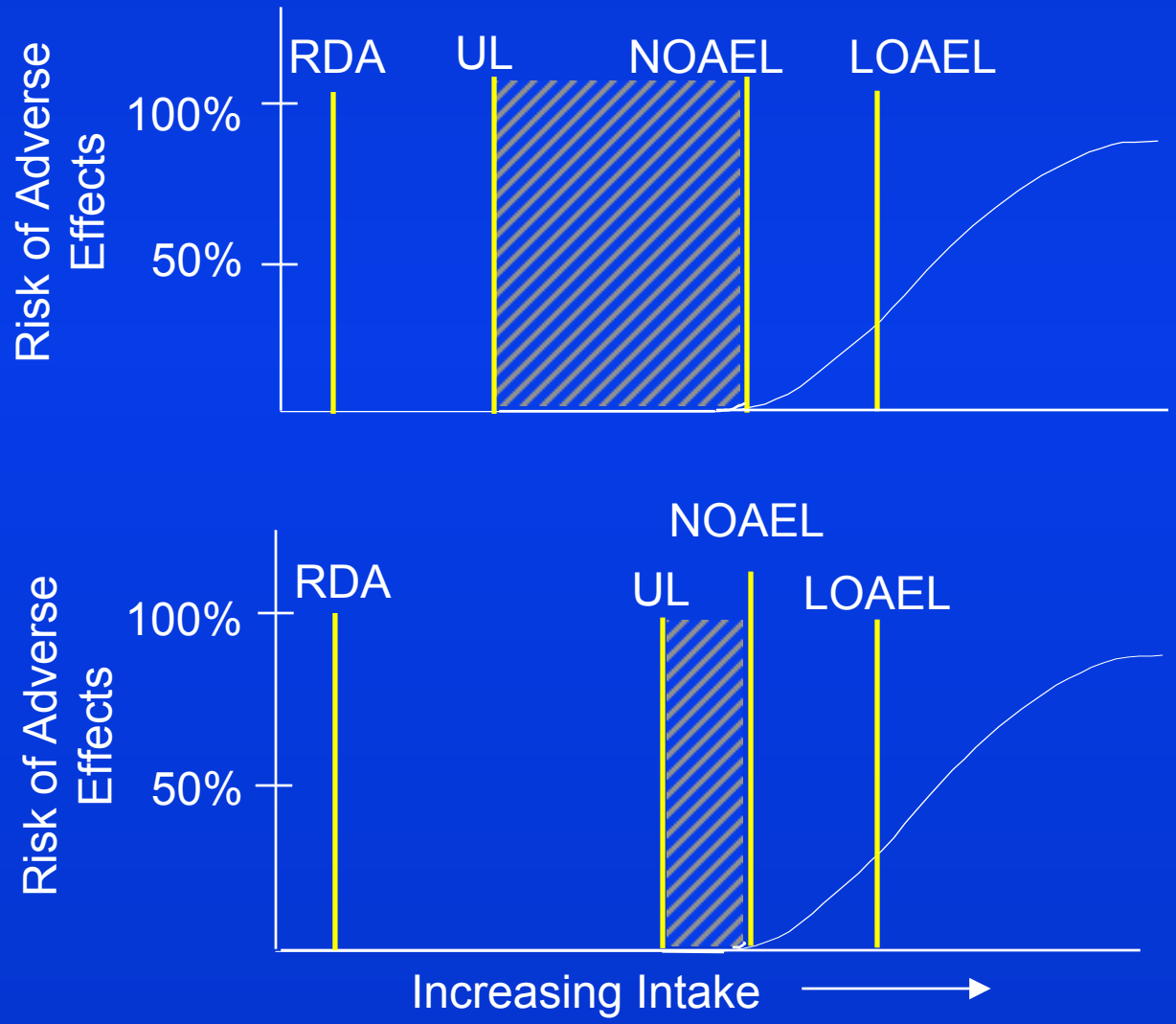
- Estimated Average Requirement (EAR)
- Recommended Dietary Allowance (RDA)
- Adequate Intake (AI)
- **Tolerable Upper Intake Level (UL)**

UL
Tolerable Upper Intake Level

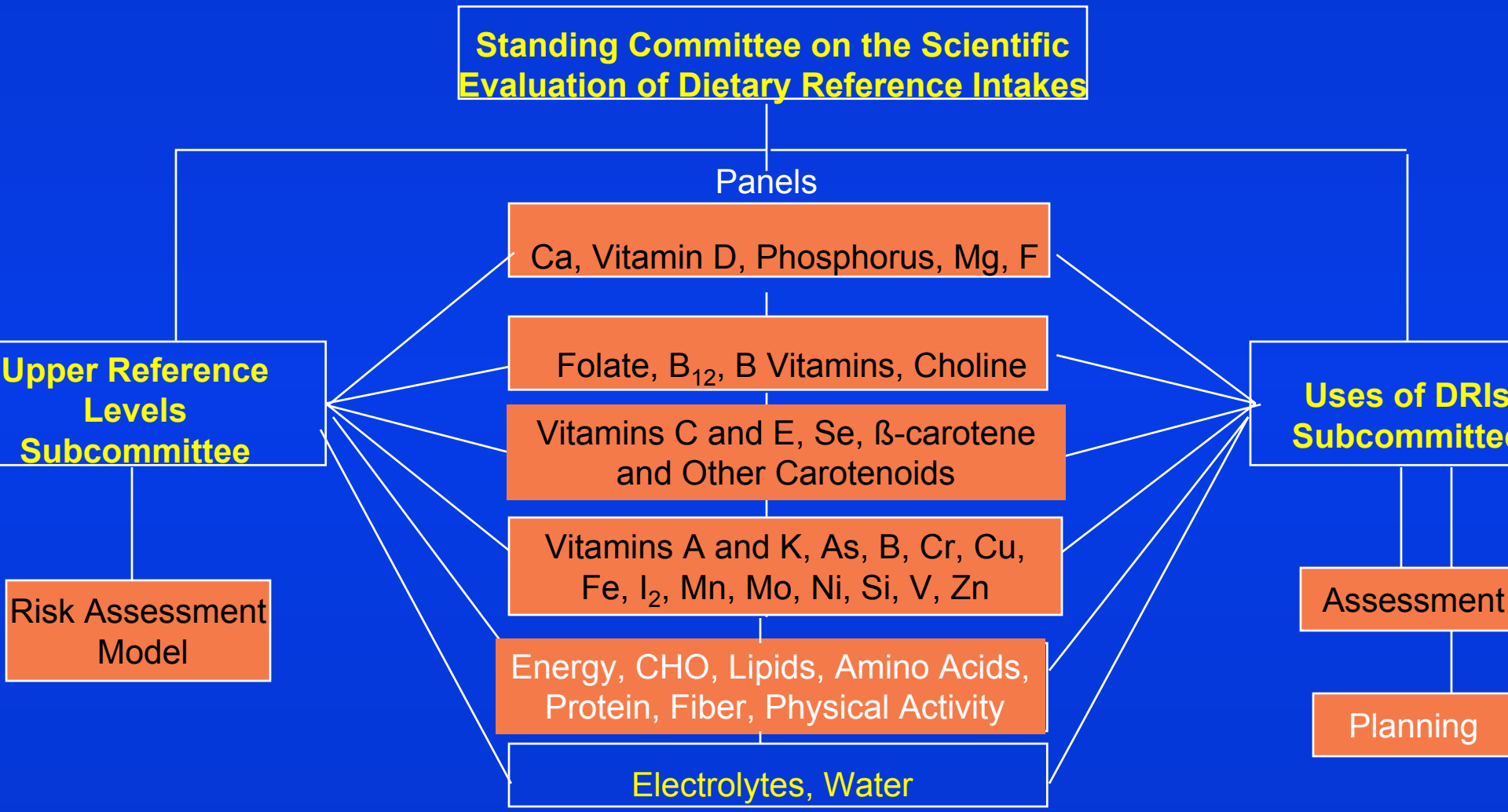
The highest level of daily nutrient intake that is likely to pose no risks of adverse health effects to almost all individuals in the general population

- Not a recommended level of intake
- Not a level that is desirable to attain

Effect of Uncertainty Assessment on UL



Dietary Reference Intakes



Timeline for DRIs

	1996	1997	1998	1999	2000	2001	2002	2003
√ Ca, P, Mg, Vit D, F	→	→						
√ Folate, B vitamins, choline		→	→					
√ Vit C, E, Se, ß-carotene and other carotenoids			→	→	→			
√ Vit A, K, B, Cr, Cu, Fe, I_2, Mn, Mo, Ni, Si, V, Zn				→	→			
√ Energy, protein, CHO, lipids				→	→	→	→	
Na, K, H_2O							→	→
√ Upper levels			→	→	→	→	→	→
√ Uses and interpretation			→	→	→	→	→	→


IOM
DRIs
Calcium
Phosphorus
Magnesium
Vitamin D
Fluoride
NATIONAL ACADEMY PRESS
IOM
DRIs: Model for Upper Intake Levels of Nutrients
NAP
IOM
DRIs
Thiamin
Riboflavin
Niacin
Vitamin B6
Folate
Vitamin B12
Pantothenic Acid
Biotin
Choline
NATIONAL ACADEMY PRESS
IOM
DRIs
Vitamin C
Vitamin E
Selenium
Carotenoids
NATIONAL ACADEMY PRESS
IOM
DRIs
Vitamin A
Vitamin K
Arsenic
Boron
Chromium
Copper
Iodine
Iron
Manganese
Molybdenum
Nickel
Silicon
Vanadium
Zinc
NATIONAL ACADEMY PRESS
IOM
DRIs: Proposed Definition of Dietary Fiber
NAP
IOM
DRIs Applications in Dietary Assessment
NATIONAL ACADEMY PRESS

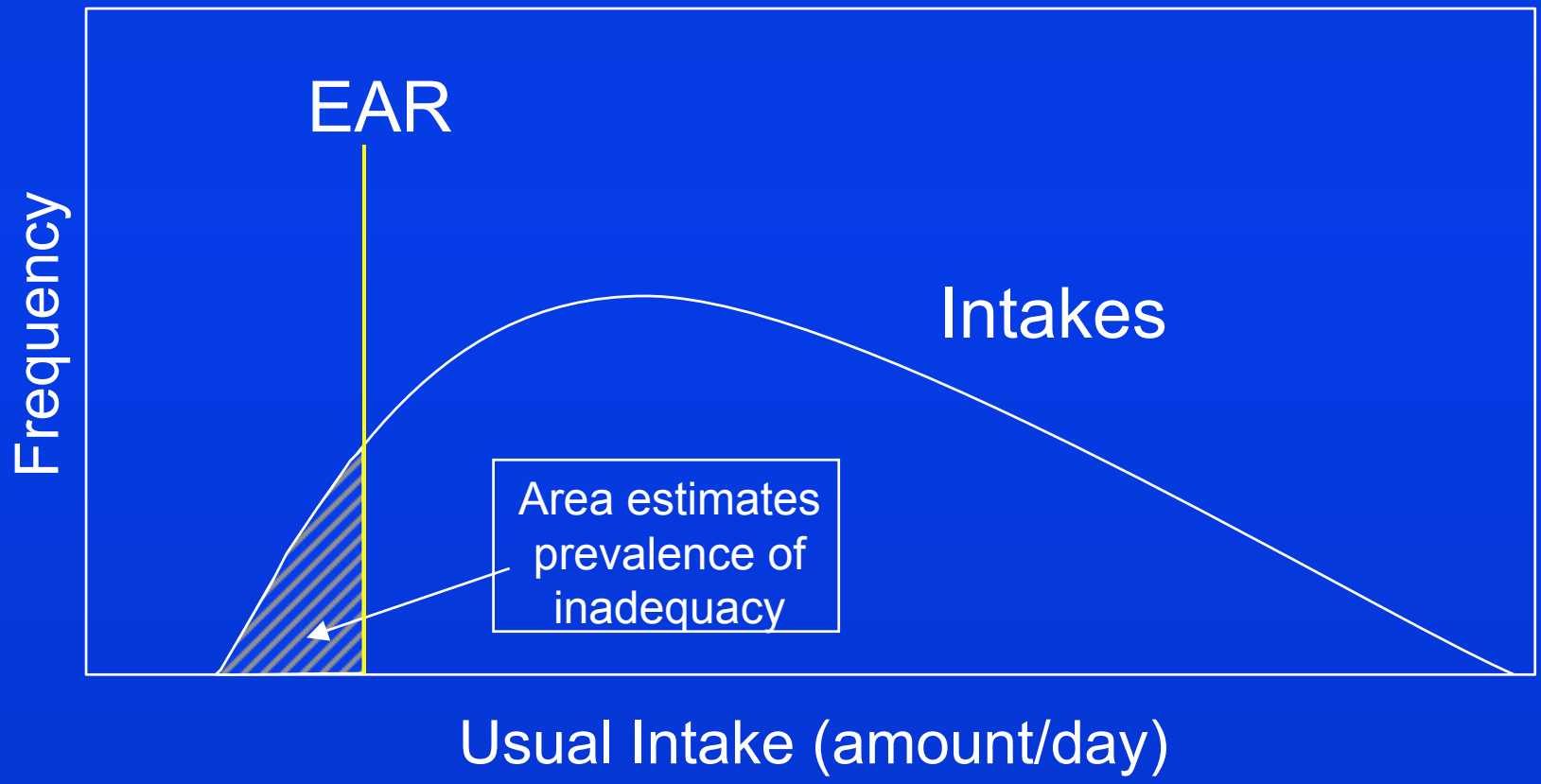
Process for Setting DRIs

- Committee of experts
- Literature review
- Solicitation of advice
  - Workshops
  - Scientific Meetings
  - Correspondence
- NRC review

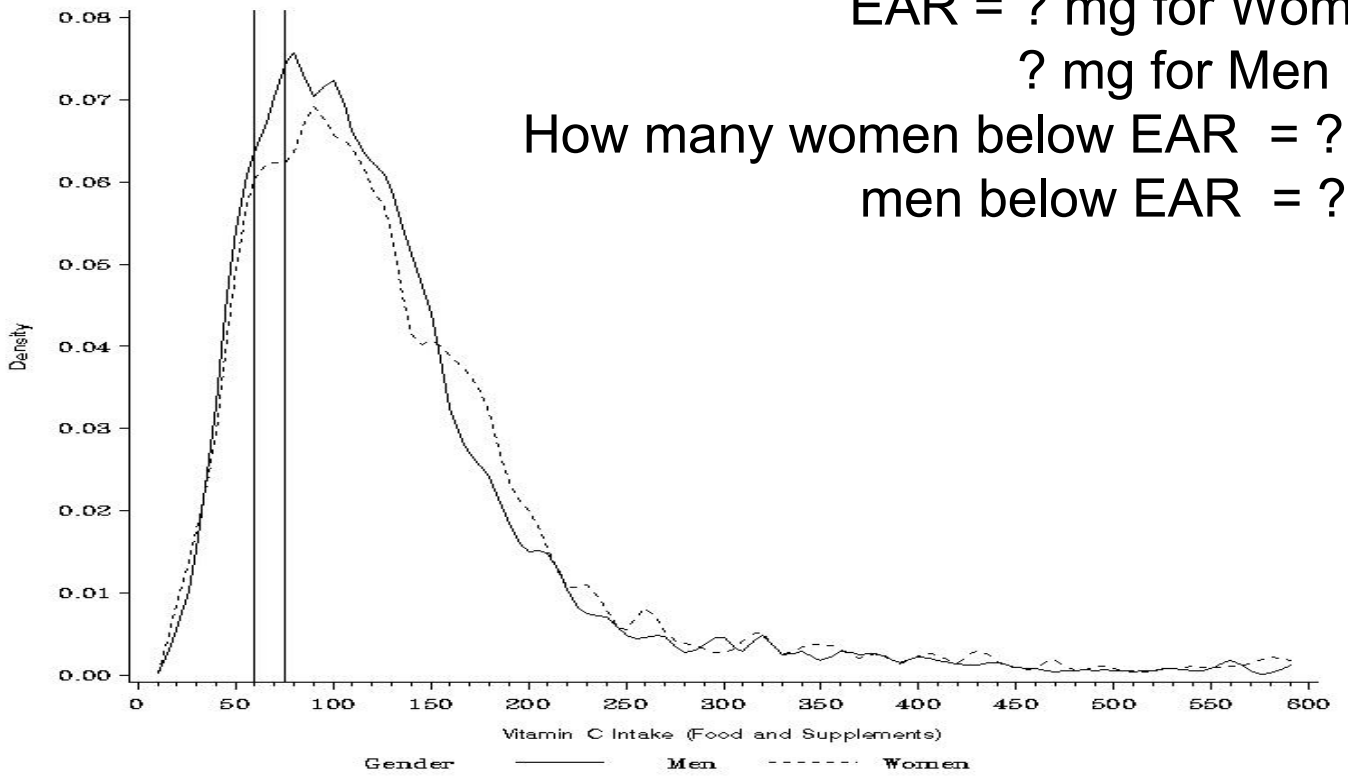
Why an EAR?

- To establish the recommendation for an individual
- To assess adequacy of population intakes

Population Prevalence of Inadequate Intakes

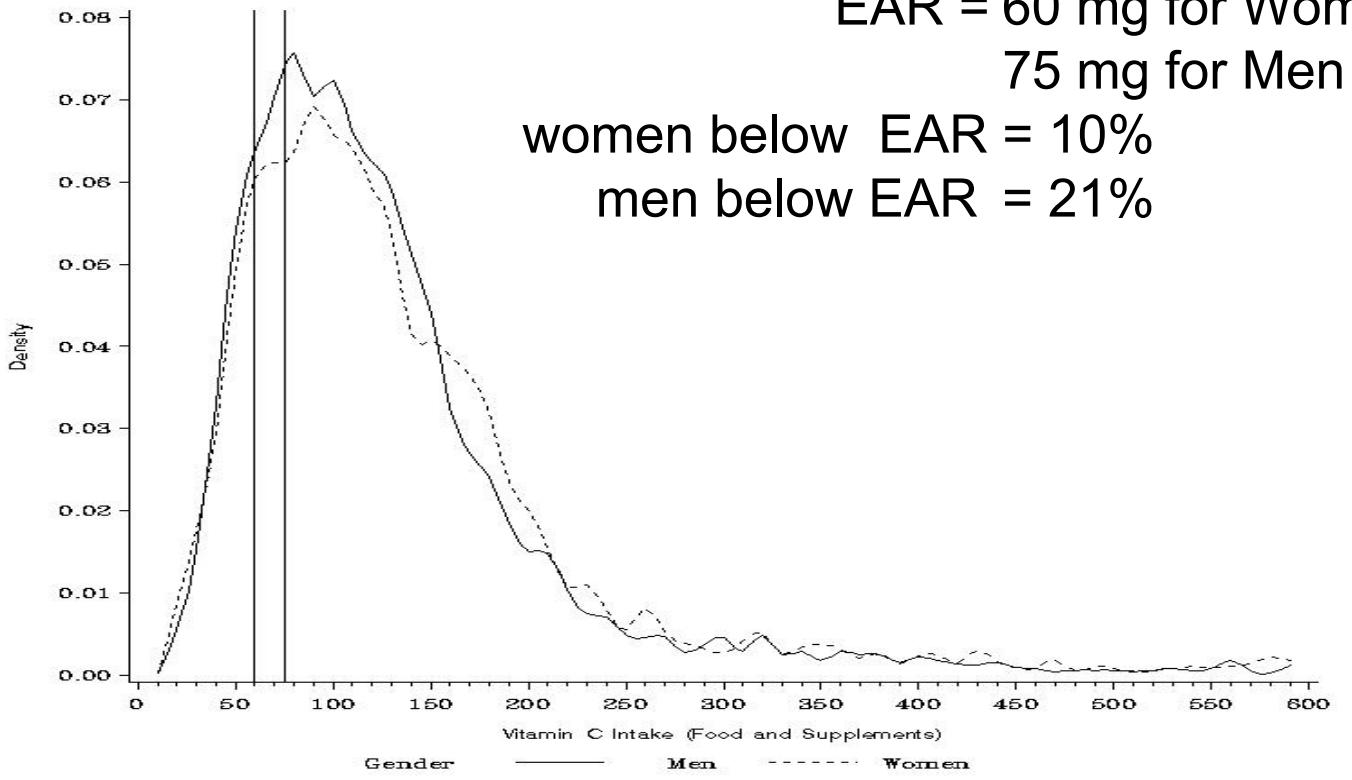


Vitamin C Intake for Men and Women Who Don't Smoke (Food and Supplements)



EAR = ? mg for Women
? mg for Men
How many women below EAR = ?
men below EAR = ?

Vitamin C Intake for Men and Women Who Don't Smoke (Food and Supplements)



EAR = 60 mg for Women
75 mg for Men

women below EAR = 10%

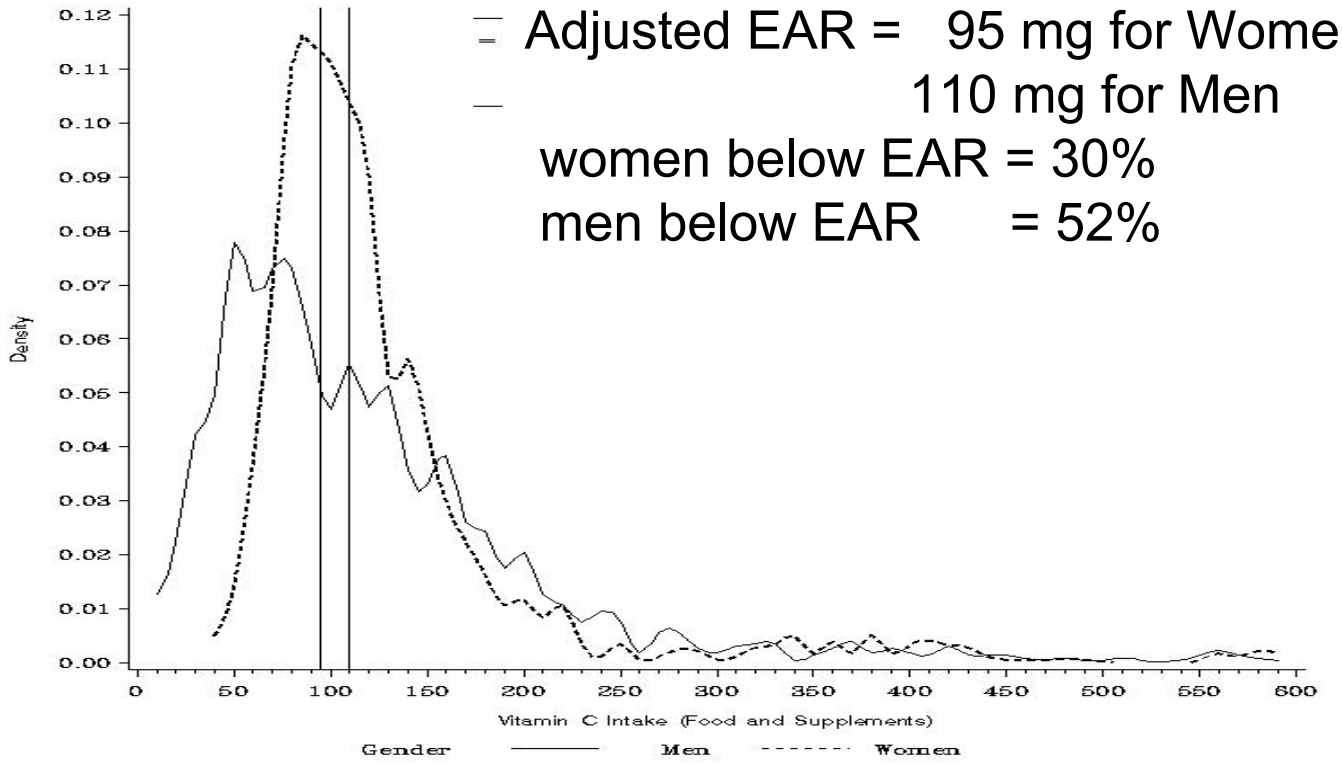
men below EAR = 21%

Does this Mean that There is a Scurvy Problem in the U.S.?

- No, it means that 10% of women and 21% of men in the U.S. do not have leukocyte ascorbate concentrations at 70% maximal saturation

- Scurvy would be unlikely unless there was no detectable vitamin C in the leukocytes

Vitamin C Intake for Men and Women Who Do Smoke (Food and Supplements)



Adjusted EAR = 95 mg for Women
110 mg for Men

women below EAR = 30%

men below EAR = 52%

Folate

- "Folate" is generic term that includes food folates (pteroylpolyglutamates) and synthetic folic acid (pteroylmonoglutamic acid).
- Food folates must be hydrolyzed in the intestine prior to absorption, and are therefore less bioavailable than synthetic folic acid.

Dietary Folate Equivalents: WHY?

ood Folate: **50%**

1 µg DFE = 1.0 µg naturally present folate

(DFE = 1 x weight)

olate from Fortified Food: **85%**

1 µg DFE = 0.6 µg added to foods

(DFE = 1.7 x weight)

olate from Supplements w/ water: **>90%**

1 µg DFE = 0.5 µg from supplements

(DFE = 2 x weight)

Folate in Foods, Supplements

	Folate µg	DFE µg
Orange juice- 120 g	100	100
Ready-to-eat cereals		
Highly fortified – 30 g	400	667
Mod. Fortified - ½ C	100	167
Noodles, rice, pasta (cooked) - 1 C	60	100
Bread - 28 g	20	33
Supplement - 1 pill	400	800

B_{12} DRIs for Adults Aged 51+ Years

10-30% adults >50 years: atrophic gastritis causing poor absorption of dietary B_{12}

Bioavailability of food-bound B_{12} for elderly may be very low for some

EAR, RDA: no change with age but B_{12} from fortified foods (such as fortified cereals) or B_{12}-containing supplements should meet most of the RDA of 2.4 µg of B_{12} daily

Vitamin A

Required for normal vision, reproduction, gene expression, embryonic development, growth, and immune function

Derivation of Retinol Equivalents

NRC, 1989

RE for dietary β-carotene: 1/3 absorption seen for supplemental β-carotene in oil) × conversion of absorbed β-carotene to vitamin A (1/2) ∴ 1/6

Vitamin A activity of β-cryptoxanthin and α-carotene is 1/2 relative to β-carotene ∴ 1/12

Derivation of Retinol Activity Equivalents

IOM, 2001

RAE for dietary β-carotene: 1/6 relative to absorption of supplemental β-carotene (in oil) × conversion of absorbed β-carotene to vitamin A (1/2) = 1/12

Vitamin A activity of β-cryptoxanthin and α-carotene 1/2 relative to β-carotene = 1/24

Comparison of 1989 and 2001 Interconversion of Vitamin A and Carotenoid Units

NRC, 1989	**IOM, 2001**
etinol equivalent (RE)	1 retinol activity equivalent (RAE)
= 1 µg all-*trans*-retinol	= 1 µg all-*trans*-retinol
= 2 µg all-*trans*-β-carotene in oil	= 2 µg all-*trans*- β-carotene in oil
= 6 µg all-*trans*-β-carotene	= 12 µg all-*trans*-β- carotene
= 12 µg other dietary provit. A carotenoids	= 24 µg other dietary provitamin A carotenoids

1 µg all-*trans*-retinol = 3.33 IU vitamin A activity from retinol (WHO, 1966)

Retinol Activity Equivalents (RAEs)

1 RAE = 1 μg retinol

= 2 μg β-carotene in oil

= 12 μg β-carotene in food

= 24 μ g α-carotene in food

= 24 μ g β -cryptoxanthin in food

For Some Nutrient Databases, RAEs can be Calculated from REs

Total vitamin A in µg RAE =

(preformed vitamin A in µg RE) +

(carotenoids in µg RE ÷ 2)

For Some Foods, RAEs can be Calculated from REs

Examples, per 100 g:

- Carrots (2,800 µg RE): 2,800 RE from carotenoids = 1,400 µg RAE
- Whole milk (31 µg RE): 31 RE preformed vitamin A = 31 µg RAE
- Spinach souffle (500 µg RE): 150 µg RE preformed vitamin A (milk) + 350 RE from carotenoids = 150 RAE + 175 RAE = 325 µg RAE

Indicators Considered for Estimating the Average Requirement for Vitamin A

- *Dark adaptation*
- Serum/plasma retinol concentration
- Isotope dilution
- Relative dose-response/modified relative dose-response
- Conjunctival impression cytology
- Immune function
- *Adequate liver stores*

Despite lower bioequivalency (RAE), the RDA for vitamin A is easy to achieve

Adverse Effects Considered in Setting the Upper Level for Vitamin A

- Bone mineral density
- *Liver toxicity*
- *Teratogenicity* (women of reproductive age)
- Bulging fontanel (infants)

Upper Levels for Vitamin A

Women of reproductive age

$$\text{NOAEL (teratogenicity)} = \frac{4{,}500 \text{ µg/day}}{\text{UF}} = \frac{4{,}500 \text{ µg/day}}{1.5} = 3{,}000 \text{ µg/day}^*$$

All other adults

$$\text{LOAEL (liver toxicity)} = \frac{14{,}000 \text{ µg/day}}{\text{UF}} = \frac{14{,}000 \text{ µg/day}}{5} = 3{,}000 \text{ µg/day}^*$$

** From pre-formed vitamin A sources only*

Tolerable Upper Intake Levels for Vitamin A (µg/day)

Life Stage	UL
0–6 mo	**600**
7–12 mo	**600**
1–3 y	**600**
4–8 y	**900**
9–13 y	**1,700**
14–18 y	**2,800**
≥ 19 y	**3,000**
Preg, Lact	**See age group**

Vitamin K

Required as a coenzyme for the synthesis of proteins active in blood coagulation
and bone metabolism

Special Considerations

- Vitamin K – Coumadin interaction
  - Patients undergoing anticoagulant therapy are advised to keep their daily vitamin K intake constant
- Vitamin K – Vitamin E interaction
  - Probably of little consequence in healthy individuals; patients undergoing anticoagulant therapy should avoid large intakes of vitamin E (> 400 IU/day)

Adverse Effects Considered in Setting the Upper Level for Vitamin K

No adverse effect of vitamin K from food were identified; therefore is there a UL?

Adverse Effects Considered in Setting the Upper Level for Vitamin K

None, so no UL was set

Iron

Component of a number of proteins including enzymes and hemoglobin

Indicators Considered for Estimating the Average Requirement for Iron

- Serum ferritin concentration
- Plasma total iron binding capacity
- Serum transferrin saturation
- Erythrocyte protoporphyrin
- Soluble serum transferrin receptor
- Hemoglobin concentration and hematocrit
- Erythrocyte indexes
- Balance studies
- *Factorial modeling*

Setting the EAR for Iron for Adults

Factorial modeling

- Basal losses
- Menstrual losses (premenopausal women)

Setting the EAR for Iron for Pregnancy

- Basal losses
- Fetal and placental iron deposition
- Increase in hemoglobin mass

Adverse Effects Considered for Setting the Upper Level for Iron*

- *Gastrointestinal distress*
- Impaired zinc absorption
- Cardiovascular disease
- Cancer

$$UL = \frac{LOAEL\ (gastrointestinal\ distress)}{UF} = \frac{70\ mg/day}{1.5} \approx 45\ mg/day$$

*May not protect individuals with hemochromatosis

Zinc

Major roles:

- Catalytic
- Structural
- Regulatory

Adverse Effects Considered in Setting the Upper Level for Zinc

- Immunological response
- Serum lipoprotein and cholesterol concentration
- *Reduced copper status*
- Reduced iron absorption
- Leukocyte copper concentration

$$UL = \frac{LOAEL\ (\text{reduced copper status})}{UF} = \frac{60\ \text{mg/day}}{1.5} = 40\ \text{mg/day}$$

Top 10 DRI Questions

- What do we do when you haven't given new recommended intakes for some nutrients such as sodium?

Top 10 DRI Questions

What do we do when you haven't given new recommended intakes for some nutrients such as sodium?

- Use the 1989 RDAs, and look for a comprehensive, one volume guide to the DRIs for use by dietitians

Elements of Energy Balance

Energy IN  Energy OUT

- Dietary energy intake

- Basal metabolic rate
- Thermic effect of foods
- Physical activity

Measurement of Energy Balance

Energy Intake

- Food freq. quest.
- 24-hr recall
- Food records
- Food weighing
- Direct observation

24 hrs

Energy Expenditure

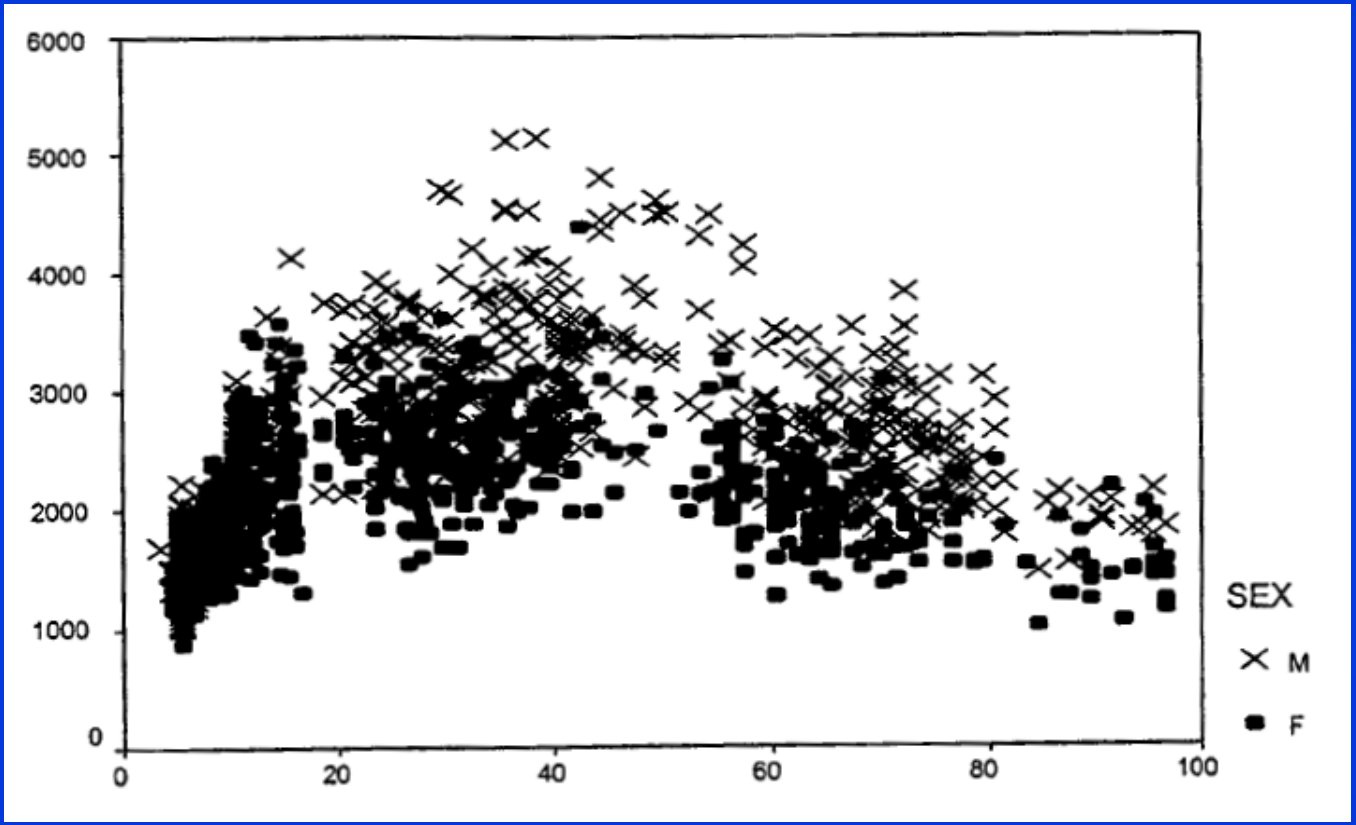
- Gas exchange calorimetry
- Heart rate monitoring
- Estimated from activity:
  - Motion sensors
  - Activity diary
  - Direct observation
- *Doubly labeled water* ($D_2{}^{18}O$)

Estimated Energy Requirement

- EER based on regression equations from estimates of energy expenditure from *doubly labeled water* studies in over 1600 people (adults and children) from investigators around the world
  - specific for gender, age, weight, height physical activity
  - used for maintaining body weight
- Closer approximation to actual energy utilization

Doubly Labeled Water Database
Total Energy Expenditure Distribution

TEE



Age, yrs

EER Prediction Equations

- Adult Man:

  EER = 662 – (9.53 x Age [yr]) + PA x (15.91 x Wt [kg] + 539.6 x Ht [m])

- Adult Woman:

  EER = 354 – (6.91 x Age [yr]) + PA x (9.36 x Wt [kg] + 726 x Ht [m])

Physical Activity Levels (PAL)

- Physical Activity Level (PAL) =
  total energy expenditure ÷ basal energy expenditure

  PA = 1.0 if PAL ≥ 1.0 < 1.4 (sedentary)
  PA = 1.12 if PAL ≥ 1.4 < 1.6 (low active)
  PA = 1.27 if PAL ≥ 1.6 < 1.9 (active)
  PA = 1.45 if PAL ≥ 1.9 < 2.5 (very active)

- Recommended PAL = ≥ 1.6 < 1.9 (active)
  - to decrease risk of chronic disease (CVD)
  - to maintain ideal body weight (BMI = 18.5 to 25)

PAL Categories and Walking Equivalence

PAL Category	PAL Values	Walking Equivalence (mi/d at 2-4 mph)
Sedentary	1.0–1.39	
Low active	1.4–1.59	1.5, 2.2, 2.9 for PAL = 1.5
Active	1.6–1.89	3.0, 4.4, 5.8 for PAL = 1.6 5.3, 7.3, 9.9 for PAL = 1.75
Very active	1.9–2.5	7.5, 10.3, 14 for PAL = 1.9 17, 23, 31 for PAL = 2.5

Estimated Standard Deviations for EER Prediction (kcal/day)

Age Group	Males	Females
3-18 y	58	68
>19 y	199	162

Estimated Energy Requirements at Recommended Level of Activity

- For adults, approximation

EER [19 y, 70 kg,177 cm] man = 2,550 - 3,543 kcal/day
[154 lb, 5’10”]

EER [19 y, 54 kg,163 cm] woman = 1,912 - 2,672 kcal/day
[119 lb; 5’4”]

- Subtract 10 kcal/day for men and 7 kcal/day for women for each year above 19 y

No UL for Energy

- An energy intake that exceeds the EER could result in weight gain--depends on how
  - —accurate the estimate is of the individual's PAL
  - —close the prediction equations are to actual requirements

Recommendation for Physical Activity

- 60 minutes of daily moderate intensity physical activity
  - To prevent weight gain
  - To accrue additional weight-independent health benefits of physical activity
  - For both children and adults
  - In addition to activities required by a sedentary lifestyle
- Corresponds to an “active” lifestyle

Protein Recommendations

- RDA = 0.8 g/kg body weight/day using meta-analysis of nitrogen balance studies
  - Same for men and women based on body weight
  - No differentiation for animal versus vegetable protein, assumes complementary protein consumption
  - No differentiation for age based on body weight (thus increased amount needed based on LBM)

FNB/IOM Protein Digestibility Corrected Amino Acid Scoring Pattern[1]

Amino Acid	mg/g Protein
Histidine	18
Isoleucine	25
Leucine	55
Lysine	51
Methionine + cysteine	25
Phenylalanine + tyrosine	47
Threonine	27
Tryptophan	7
Valine	32

[1]Based on EARs for 1-3 y for indispensable amino acids

Dietary Fat

- Total fat
- Saturated fat
- Monounsaturated fatty acids
- *n*-6 Polyunsaturated fatty acids
- *n*-3 Polyunsaturated fatty acids
- *Trans* fatty acids
- Cholesterol

No Recommended Intakes for Total Fat; Saturated, Monounsaturated, or *Trans* Fatty Acids; or Cholesterol

- No defined intake (dose response) level for setting a recommended intake (total fat)
- Synthesized at adequate levels (saturated and monounsaturated fatty acids, and cholesterol)
- No independent beneficial role in human health (monounsaturated fatty acids, *trans* fatty acids, cholesterol)

Criteria and AIs* for Linoleic Acid (g/day)

Life Stage	Criterion	Male	Female
0-6 m	Milk intake	4.4	4.4
7-12 m	Milk + complementary foods	4.6	4.6
1-3 y	Median intake	7	7
4-8 y	Median intake	10	10
9-13 y	Median intake	12	10
14-18 y	Median intake	16	11
19 - 50 y	Median intake	17	12
> 50 y	Median intake	14	11
Pregnancy	Median intake		13
Lactation	Median intake		13

*Assumed adequate to prevent EFA deficiency (rare in the U.S. and Canada)

Criteria and AIs* for Alpha-Linolenic Acid (g/day)

Life Stage	Criterion	Male	Female
0-6 m	Milk intake	0.5	0.5
7-12 m	Milk + complementary foods	0.5	0.5
1-3 y	Median intake	0.7	0.7
4-8 y	Median intake	0.9	0.9
9-13 y	Median intake	1.2	1.0
14-18 y	Median intake	1.6	1.1
19 +	Median intake	1.6	1.1
Pregnancy	Median intake		1.4
Lactation	Median intake		1.3

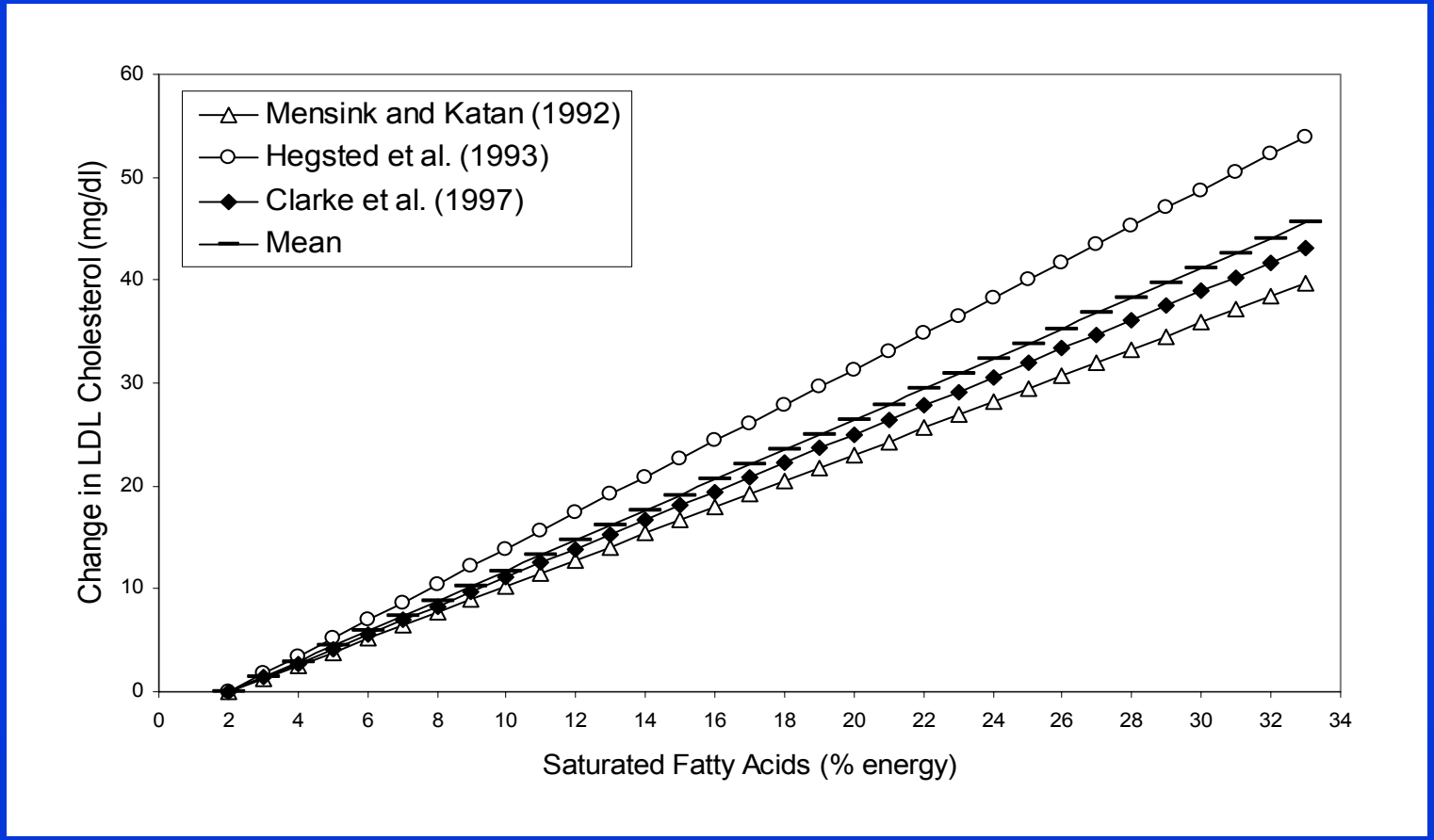
*Assumed adequate to prevent EFA deficiency (rare in the U.S. and Canada)

No ULs Set for

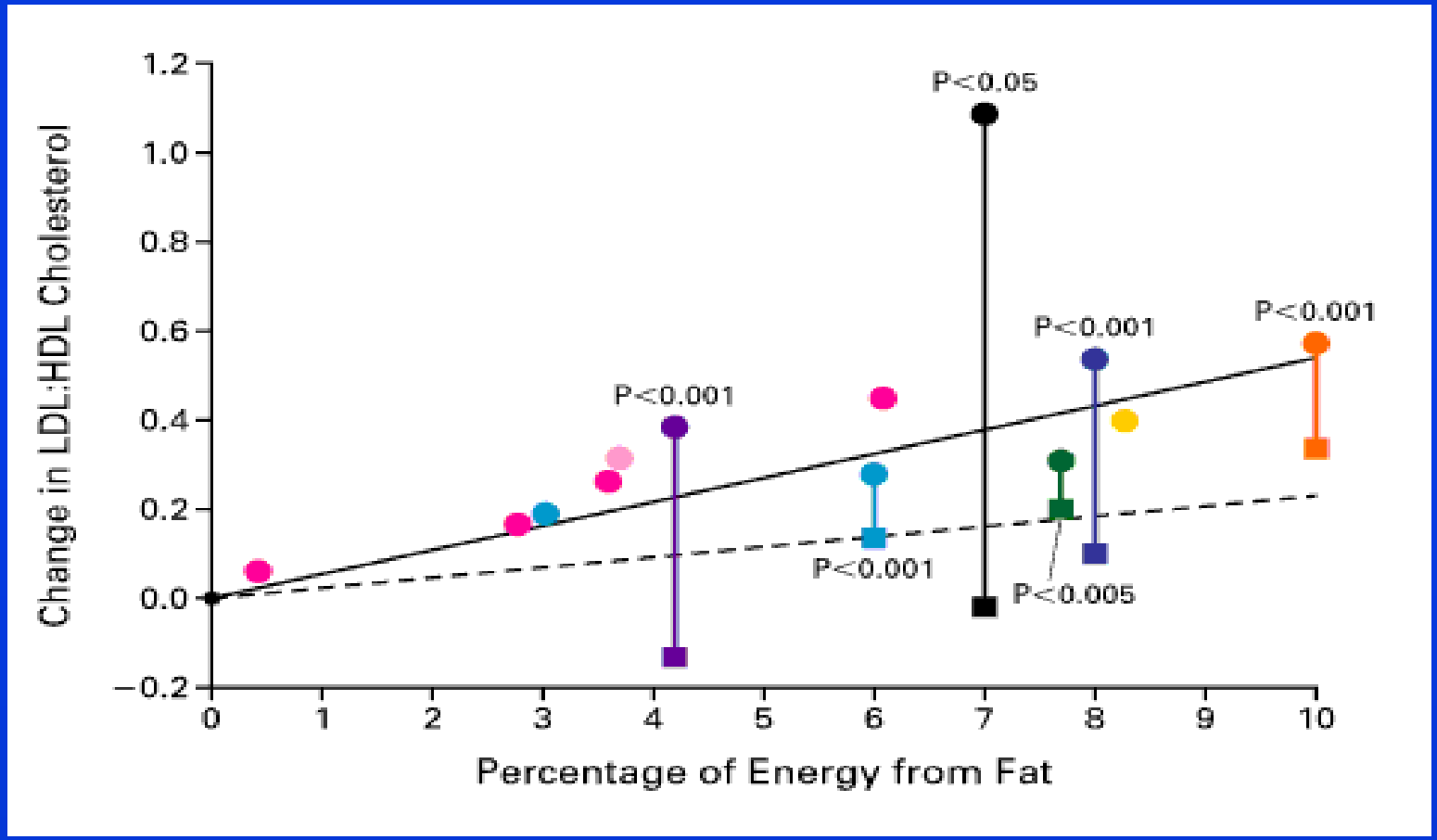
- Total fat
- Saturated fat
- Monounsaturated fat
- *n*-6 Polyunsaturated fats
- *n*-3 Polyunsaturated fats
- *Trans* fat
- Cholesterol

WHY?

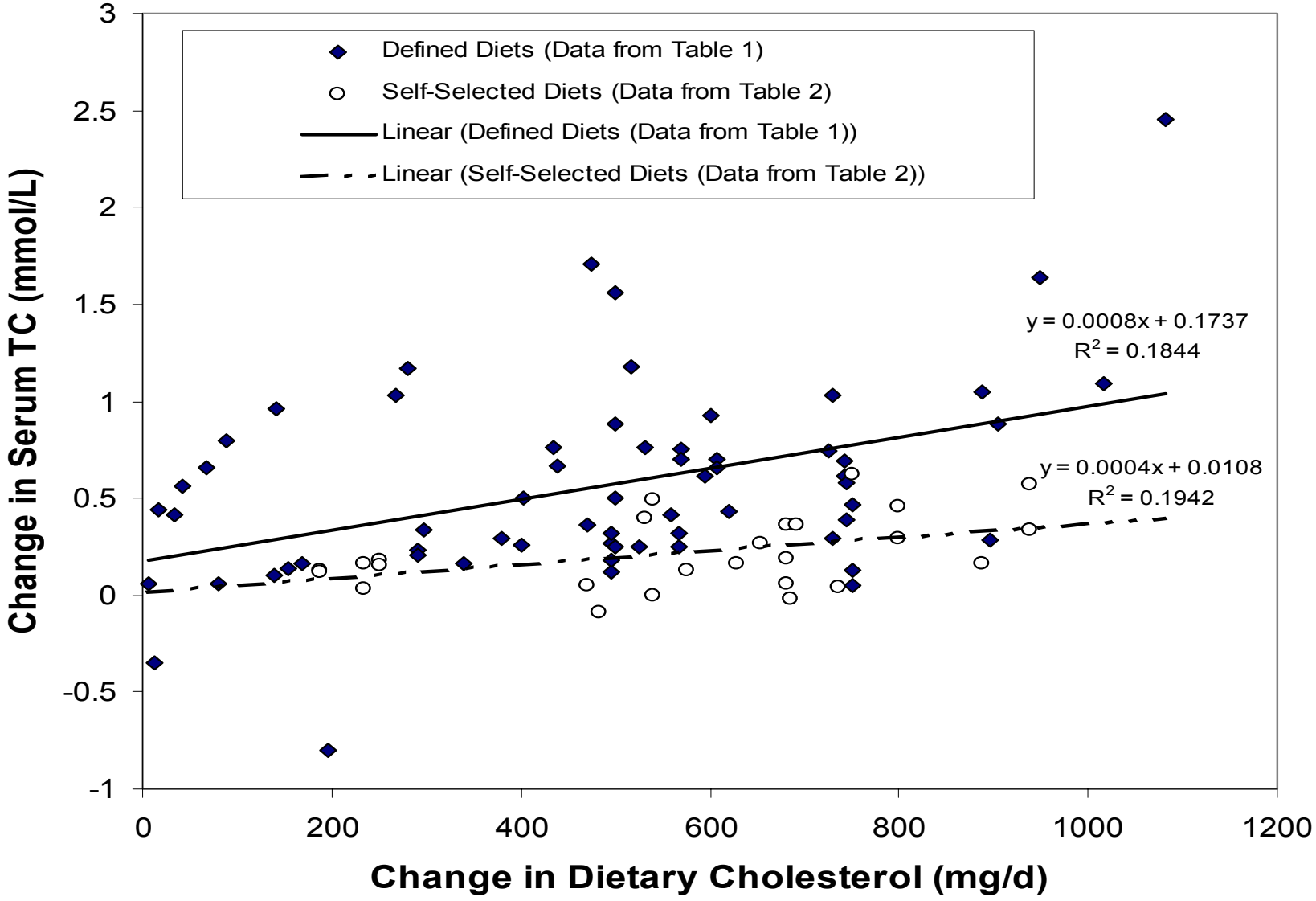
Calculated Changes in Serum LDL Cholesterol Concentration in Response to Percent Change in Dietary Saturated Fatty Acids



Trans Fatty Acid and Saturated Fat Intake and LDL:HDL Cholesterol Ratio



ncreasing Intake of Cholesterol on Serum Total Cholesterol



Primary Fat Recommendation

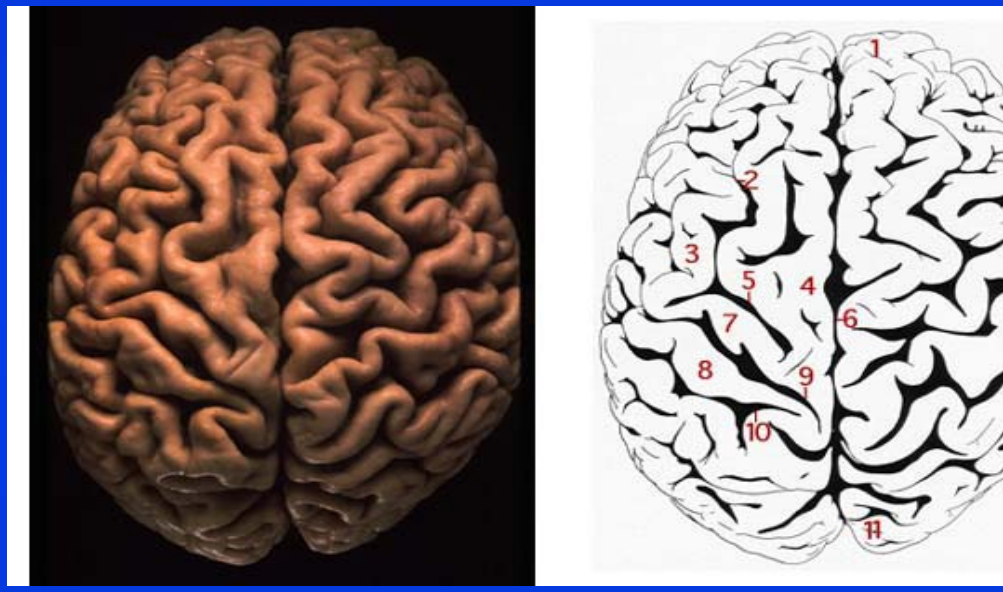
Minimize saturated and *trans* fatty acid, and cholesterol consumption while consuming a nutritionally adequate diet

Major Findings for Carbohydrate and Fiber

- The establishment of an RDA for carbohydrate—how much?
- A recommendation on “added sugar” consumption
- The development of definitions for Fiber and an AI for total fiber
- The development of an acceptable range for carbohydrate

The Establishment of an RDA for Carbohydrate

- RDA is 130 g carbohydrate/day
- Based on the amount of glucose needed by the brain
- Based on studies in which glucose use by the brain was determined by A-V difference across the brain in humans



How Does a 130 g/day Carbohydrate Die Compare to . . .

- Typical 2,000 kcal diet
  - 130 g of carbohydrate = 130 × 4 kcal/g = 520 kcal/day
  - 520 ÷ 2,000 = ~25% of kcal
- Low carbohydrate diets
  - Recommend <20 g for 1st two weeks
  - Probably not over 40 g to stay in ketosis

Recommendation on "Added Sugar" Consumption

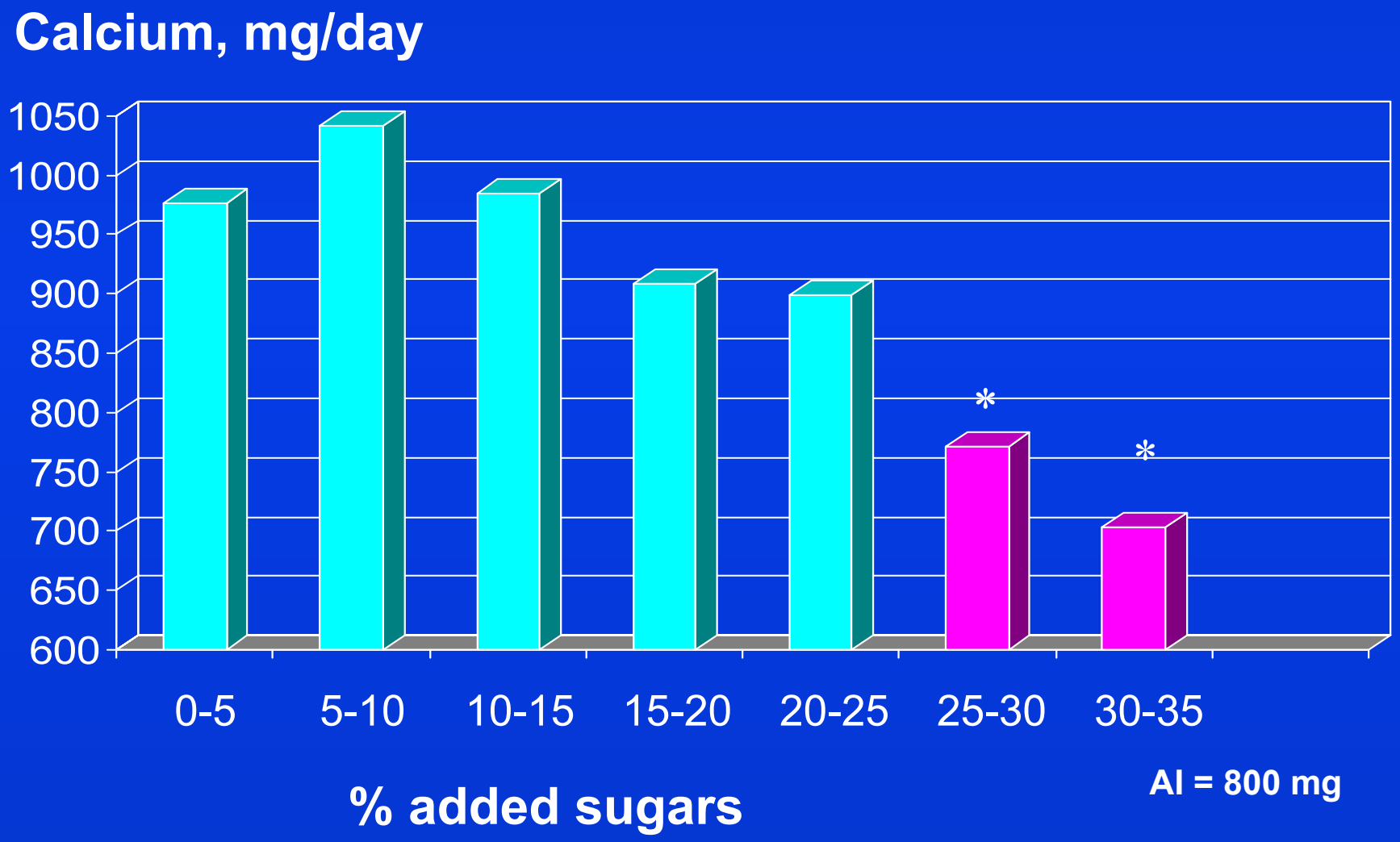
"Added Sugars"

- Sugars and syrups added to foods during processing or preparation
- Major sources: soft drinks, cakes, cookies, pies, fruitades, fruit punch, dairy desserts, candy

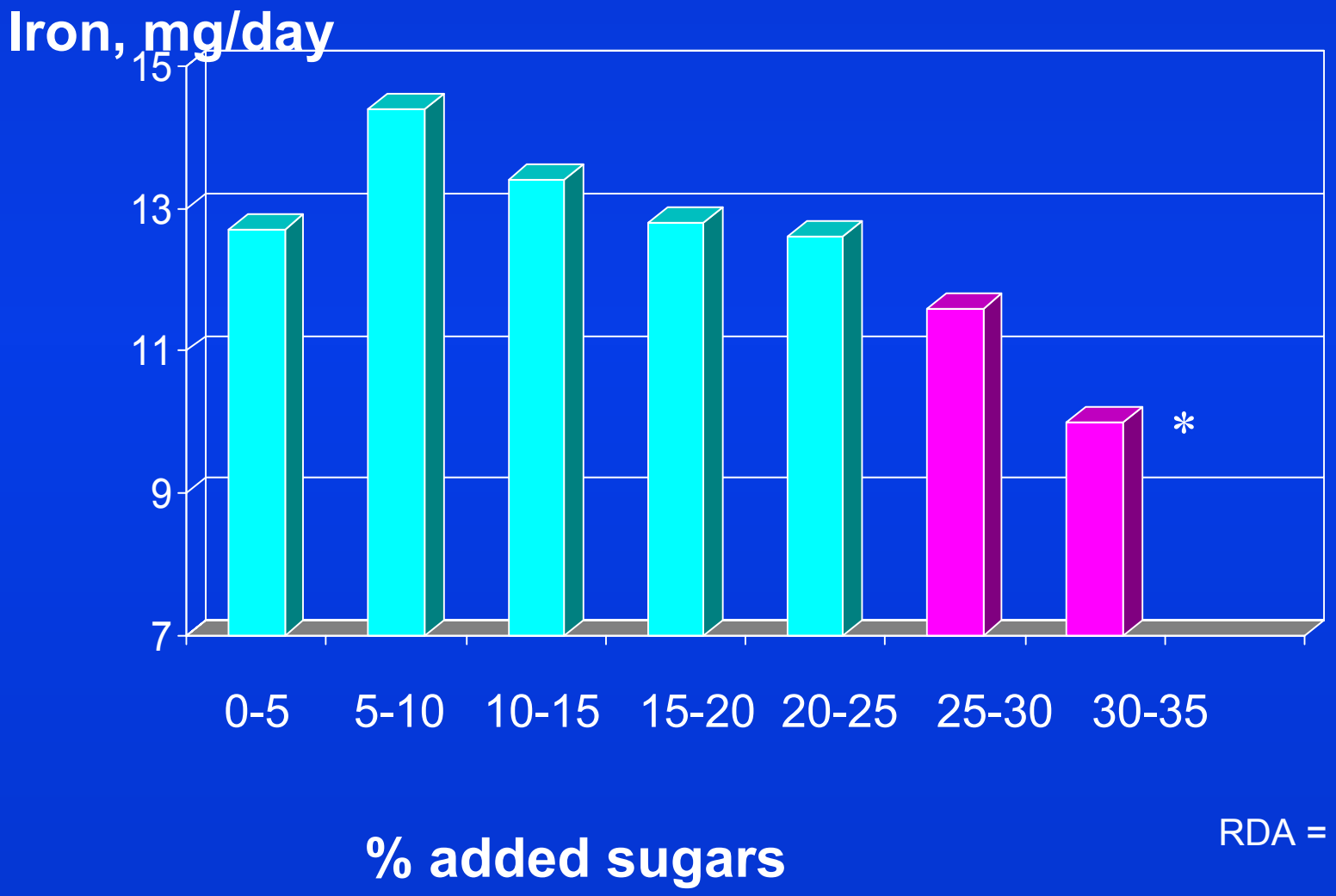
Recommendation for "added sugars" is that they not be more than 25% of total kcal

- Based on increased incidence of inadequate intakes of other nutrients as "added sugar" intake increased

Calcium Intake in Children 4-8 y as a Function of Added Sugar Intake



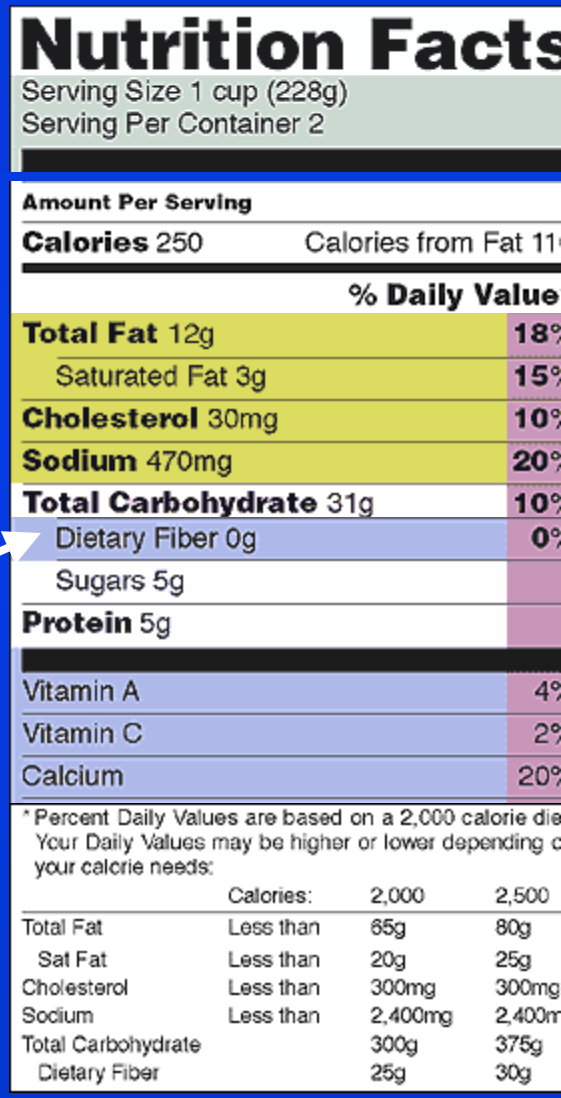
Iron Intake in Children 4-8 y as a Function of Added Sugar Intake



RDA = 10 mg

Status of the Definition of Fiber in the US

- In the US, there is no formal definition
  - The Nutrition Labeling and Education Act (1990) Required Dietary Fiber to be on the nutrition label
  - Dietary Fiber defined by a number of analytical methods



Dietary fiber

Definitions of Fiber

- *Dietary Fiber* consists of nondigestible carbohydrates and lignin that are intrinsic and intact in plants
- *Functional Fiber* consists of isolated, nondigestible carbohydrates that have beneficial physiological effects in humans

Total Fiber is the sum of *Dietary Fiber* and *Functional Fiber*

Endpoints Considered for Setting An Adequate Intake (AI) for Total Fiber

Prevention of hyperlipidemia, hypertension, and coronary heart disease

Gastrointestinal health
- Ulcers
- Colon health (laxation, etc.)

- Prevention of cancer
  - Colon
  - Breast
- Glucose tolerance, insulin response, diabetes
- Satiety and weight maintenance

Mechanisms by Which Fiber Decreases CHD Risk

- Lowering serum cholesterol
- Delayed absorption of nutrients
  - Increased insulin sensitivity
  - Decreased triglycerides
- Decreased hypertension
- Other phytochemicals that come with fiber ??

Basis for Setting an AI for Total Fiber

- Three energy-adjusted prospective studies showing the greatest reduction in risk for CHD at the highest quintile of intake

- 14 g/1,000 kcal × median energy intake (kcal/day) = g/day
- AI =

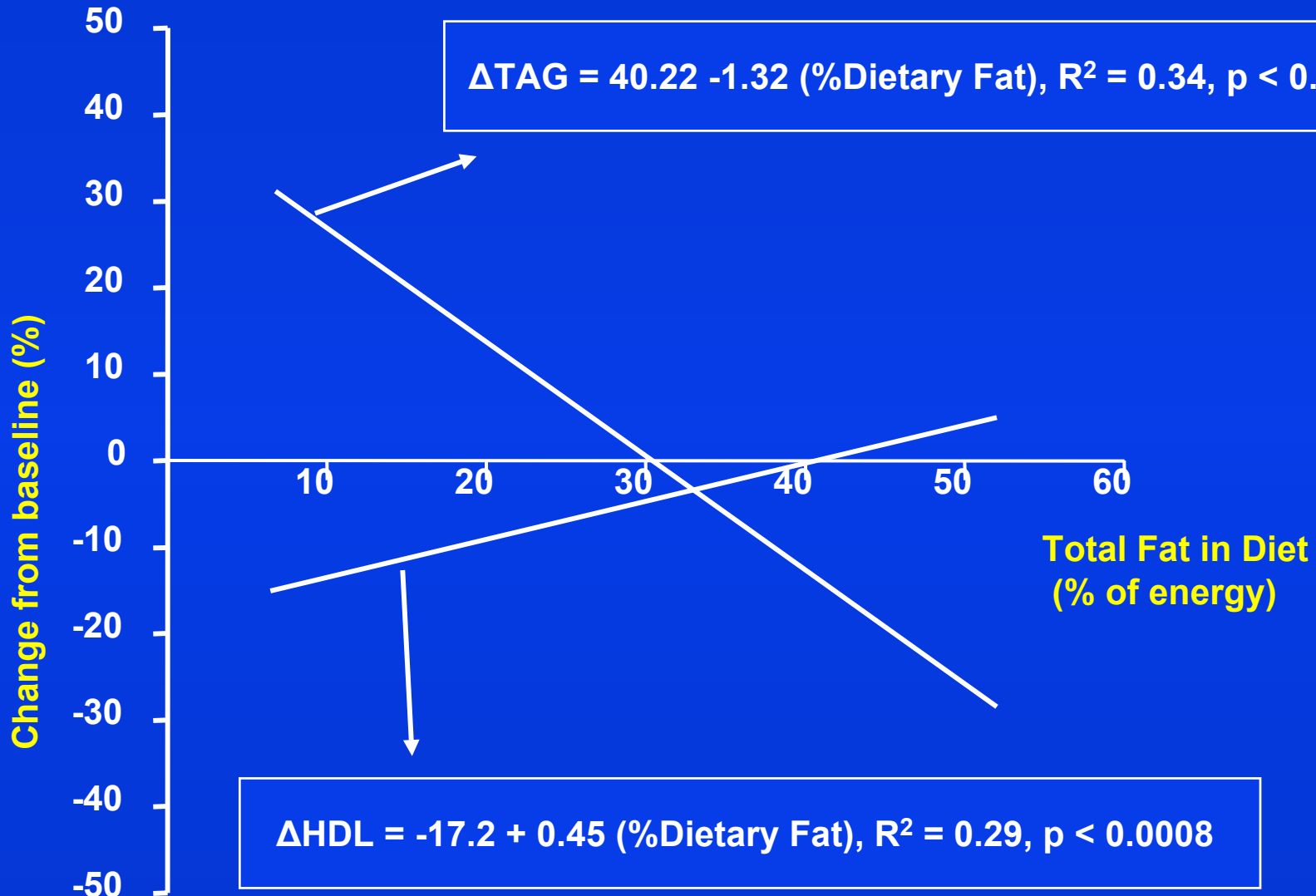
	Men	Women
< 50 y	38 g/day	25 g/day
> 50 y	30 g/day	21 g/day

Acceptable Macronutrient Distribution Range (AMDR)

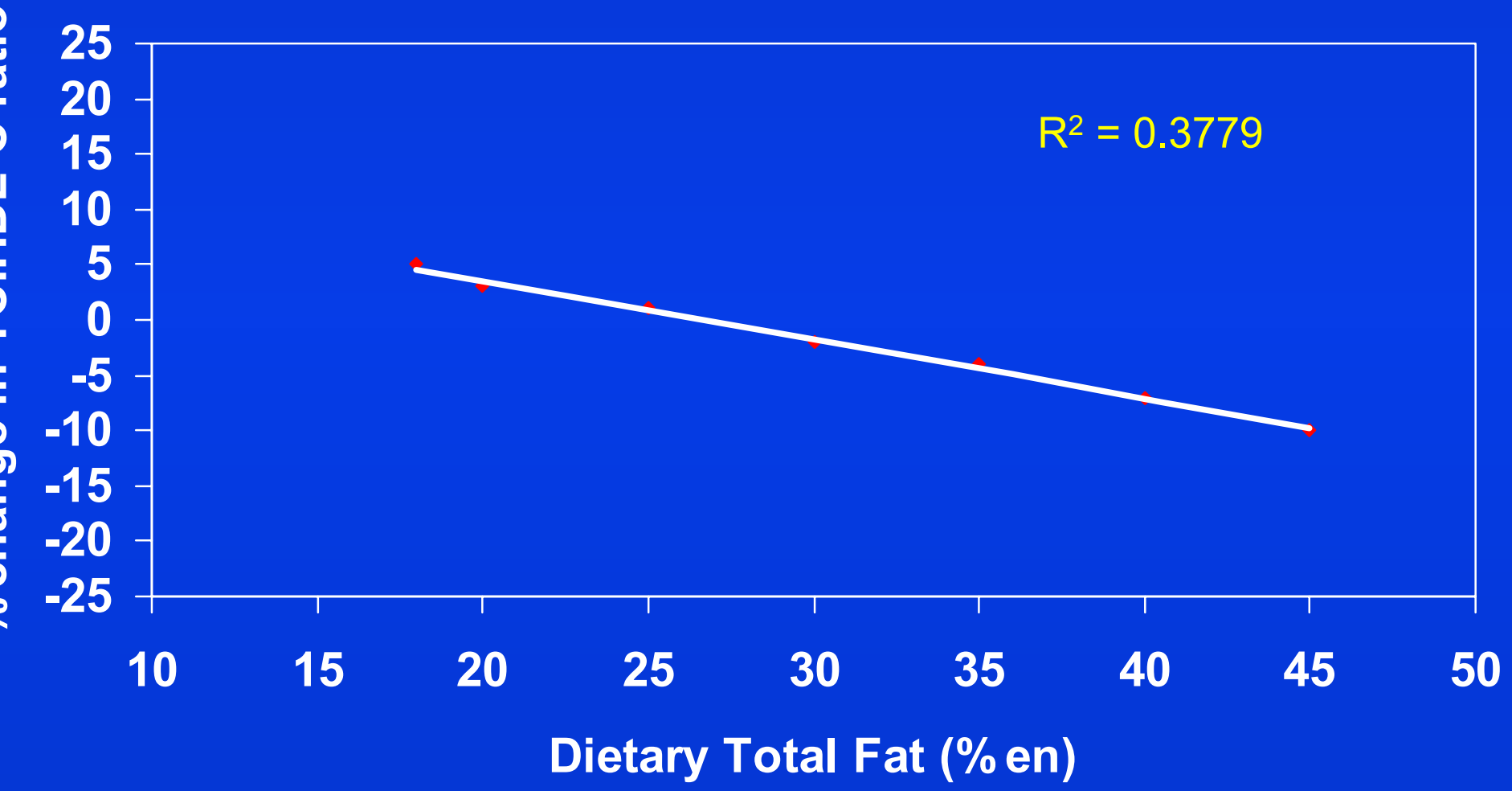
Range of intakes for an energy-yielding macronutrient that:

- Is associated with reduced risk of chronic disease
- Provides adequate intakes of essential nutrients

Results of Meta-analyses Total Fat, TAG, HDL-C



Relationship between Changes in Total Fat Intake and TC:HDL-C Ratio



Macronutrients with an AMDR

For adults:

- Protein: 10-35%
- Fat: 20-35%
- Carbohydrate: 45-65%

- *n*-6 Linoleic fatty acid: 5-10%
- α-Linolenic acid: 0.6-1.2%

  [with up to 10 % from longer chain n-3 fatty acids]

Pregnant Vegetarian Mother of Two

- 33 years old
- 9th week of pregnancy
- 5’5” tall, 115 lb
- Swims daily; used to run daily
- On vegan diet for 2 y
- Has just started taking pregnancy capsule

Planning for Her Diet Using the DRIs

Assignment: plan for

- Energy
- Protein
- Macronutrient distribution
- Fiber
- Iron
- Calcium
- B_{12}

Planning for Energy

- Two possible approaches:
  - estimate her “usual intake” during interview
  - estimate her requirement using the EER regression equation
  - Approximate using the simplified equation

What equation to use?

Planning for Energy

- EER equation for women:

EER = 354.1 - 6.91 x age (y) + PA x
(9.36 x wt [kg] + 726 x ht [m])

Planning for Energy

- EER equation: need to know
  - Age,
  - Height,
  - Weight, and
  - Physical activity level (PAL)

Planning for Energy

- EER equation:

EER = 354.1 - 6.91 x age (y) + PA x (9.36 x wt [kg] + 726 x ht [m])

Age = 30 y
Height = 5’5” (1.65 m)
Weight = 115 lb (52 kg)
Physical activity level (PAL) = ?

Planning for Energy

- EER equation for women:

EER = 354.1 - 6.91 x age (y) + PA x
(9.36 x wt [kg] + 726 x ht [m])

Estimating Physical Activity Level

Physical Activity Level (PAL)	Multiples of BMR	Examples of Activity
Sedentary	1.0 - <1.4	Activities of Daily Living (ADL) only
Low Active	≥1.4 - <1.6	Walking 2-3 miles/d plus ADL
Active	≥1.6 - <1.9	Walking ~5-8 miles/d plus ADL
Very Active	≥1.9 - <2.5	Walking ~10-20 miles/d plus ADL

Estimating Physical Activity Level

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Very Active	≥1.9 - <2.5	Walking ~10-20 mi/d plus ADL

Physical Activity Coefficients for Women Ages ≥19

Physical Activity Level (PAL)	Multiples of BMR	Physical Activity Coefficient
Sedentary	1.0 - <1.4	1.0
Low Active	≥1.4 - <1.6	1.12
Active	≥1.6 - <1.9	1.27
Very Active	≥1.9 - <2.5	1.45

EER for Client

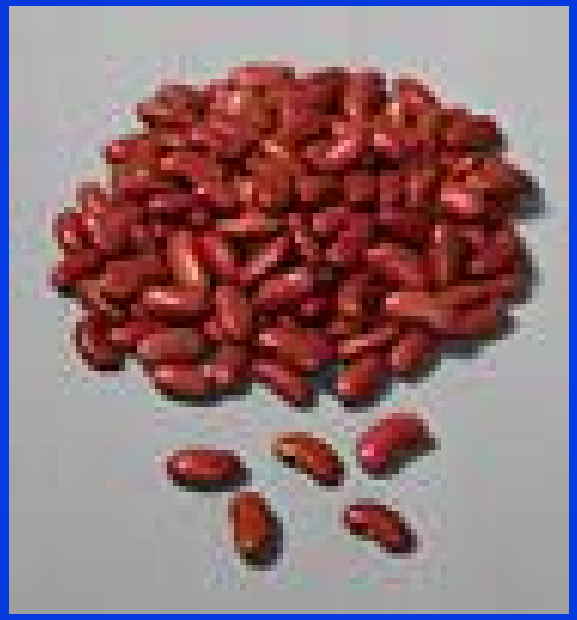
- EER = 354.1 – 6.91 x age (y) + PA x (9.36 x wt [kg] + 726 x ht [m])
- EER = 354.1 – (6.91 x 33) + 1.27 (9.36 x 52 + 726 x 1.65) =

about 2,270 kcal

Points to Remember When Planning for Energy

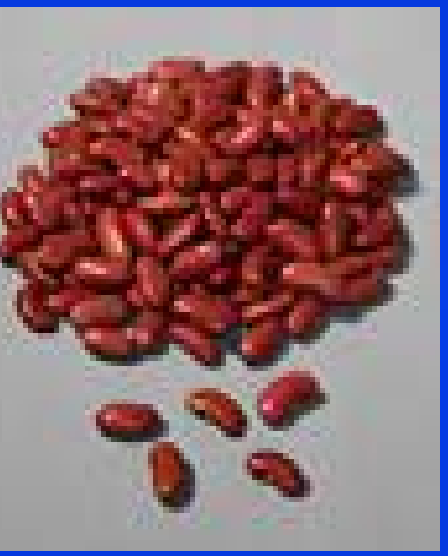
- EER is *midpoint* of range of energy requirements for those with her characteristics (~2,270 kcal)
- SD ~160 kcal, so her energy requirement is between 2,110 and 2,430 kcal/d
- Therefore, initially use as goal of usual intake = 2,270 kcal

Planning for Protein



- Insufficient evidence that activity increases protein requirements
- Protein needs during pregnancy increase during second and third trimesters by 25 g/day

Planning for Protein



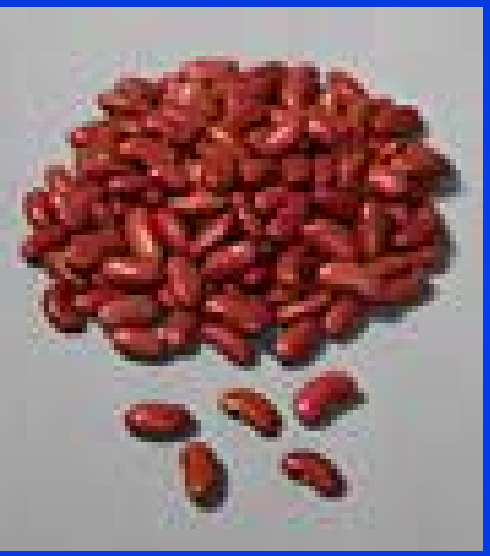
Two ways:

- RDA for reference woman = ? g/d

OR

- RDA for women = 0.8 g/kg x B Wt.

Planning for Protein



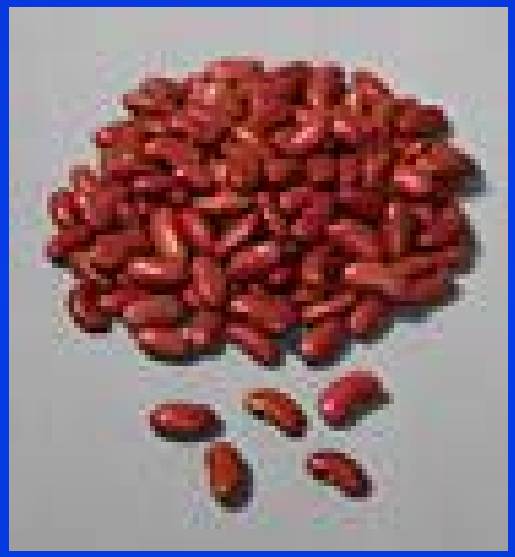
Two ways:

- RDA for reference woman = 46 g

OR

- RDA for women = 0.8 g/kg x 52 kg
  42 g

Planning for Protein



Two ways:

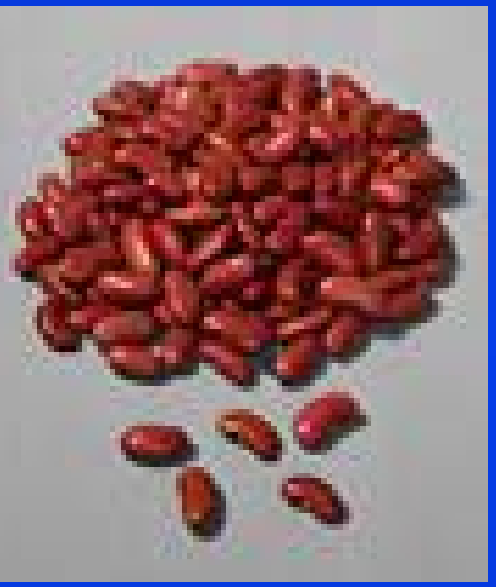
- RDA for pregnancy =
  46 g + 25 g = 71 g/day

OR

- RDA for this pregnant woman
  = 1.1 g/kg x 52 kg = 58 g/day

At term, + 15 kg = 67 kg = 74 g/day

Planning for Protein



- What about vegetarianism?
  - FNB/IOM Scoring Pattern designed to determine if proteins in diet provide adequate indispensable amino acids
  - Vegan diets may be inadequate in
    - Lysine (low in wheat, etc.)
    - Sulfur amino acids (methionine and cysteine) (low in beans & peas)
    - Tryptophan (low in corn)

Protein Sources and the FNB/IOM Scoring Pattern (mg aa/g protein)

Protein	Lysine	Threonine	Tryptophan	Sulfur
IOM/FNB Pattern*	**51**	**27**	**7**	**25**
Beef	83	44	11	37
Egg	70	49	16	56
Wheat	28	30	13	39
Brown rice	38	37	13	35
Almonds	29	32	15	25
Chickpeas	67	37	10	26

Planning for Macronutrient Distribution

Macronutrient	AMDR*	Range for Client
Carbohydrate	45-65%	?
Fat	20-35%	?
Protein	10-35%	?

* AMDR = Acceptable Macronutrient Distribution Range

** 42 g (RDA for 52 kg woman) = 6.5% of energy

Planning for Macronutrient Distribution

Macronutrient	AMDR*	Range for Client
Carbohydrate	45-65%	255 – 370 g
Fat	20-35%	50 – 90 g
Protein	10-35%	71 – 200 g**

* AMDR = Acceptable Macronutrient Distribution Range

** 42 g (RDA for 52 kg non-pregnant woman) = 6.5% of energy

- 71 g (RDA for pregnant woman) = 12.5% of energy

Planning for Fiber

Recommendation based on amount of ratio of 14.1 g fiber/1,000 kcal

- Amount for Client:

  Nonpregnant AI = ?

  Pregnant AI = ?

Planning for Fiber

Nonpregnant AI = 25 g/day

Pregnant AI = 28 g/day

Planning for Iron

- Iron RDA assumes approximately 18 percent of dietary iron is bioavailable based on dietary heme iron content of 10 to 15 % of total iron in diets in the U.S. and Canada

- Bioavailable iron from vegetarian diets estimated to be about 10 percent; thus vegetarians need about 1.8 x the RDA for nonvegetarians

Planning for Iron

- IRON RDA for nonpregnant women?
- IRON RDA for pregnant women?
- How much is it increased for vegetarian women?
- What is the UL for Iron? Is this a problem?

Planning for Iron

- RDA for iron for nonpregnant women
  31-50 y = 18 mg/day

- RDA for iron for pregnant women
  31 - 50 y = 27 mg/day

Planning for Iron

- RDA for iron for nonpregnant women
  31 - 50 y = 18 mg/day
- RDA for Iron for pregnant women
  31 - 50 y = 27 mg/day
- Vegetarians:
  - Nonpregnant 32 g/day
  - Pregnant 49 g/day
- UL = 45 g/day, based on absorption of 18%

Planning for Calcium

- Calcium AI based on decreasing risk of bone fracture and ability to maximally store dietary calcium

- What is the AI for calcium for non-pregnant 33-year-old? Pregnant 33-year-old?

Planning for Calcium

- AI for women 31 – 50 y = 1,000 mg
- AI for pregnant women = 1,000 mg
- No evidence for increased dietary need for calcium during pregnancy or lactation due to changes in absorption

Planning for Vitamin B_{12}

- Vitamin B_{12} needed for normal red blood cell formation and for normal neurological function

- Amount for client:

  Nonpregnant AI = ?

  Pregnant AI = ?

- What is the UL for Vitamin B_{12}?

Planning for Vitamin B_{12}

Requirements for normal absorption of vitamin B_{12}:

- Intact stomach
- Intrinsic factor
- Pancreatic sufficiency
- Functioning terminal ileum

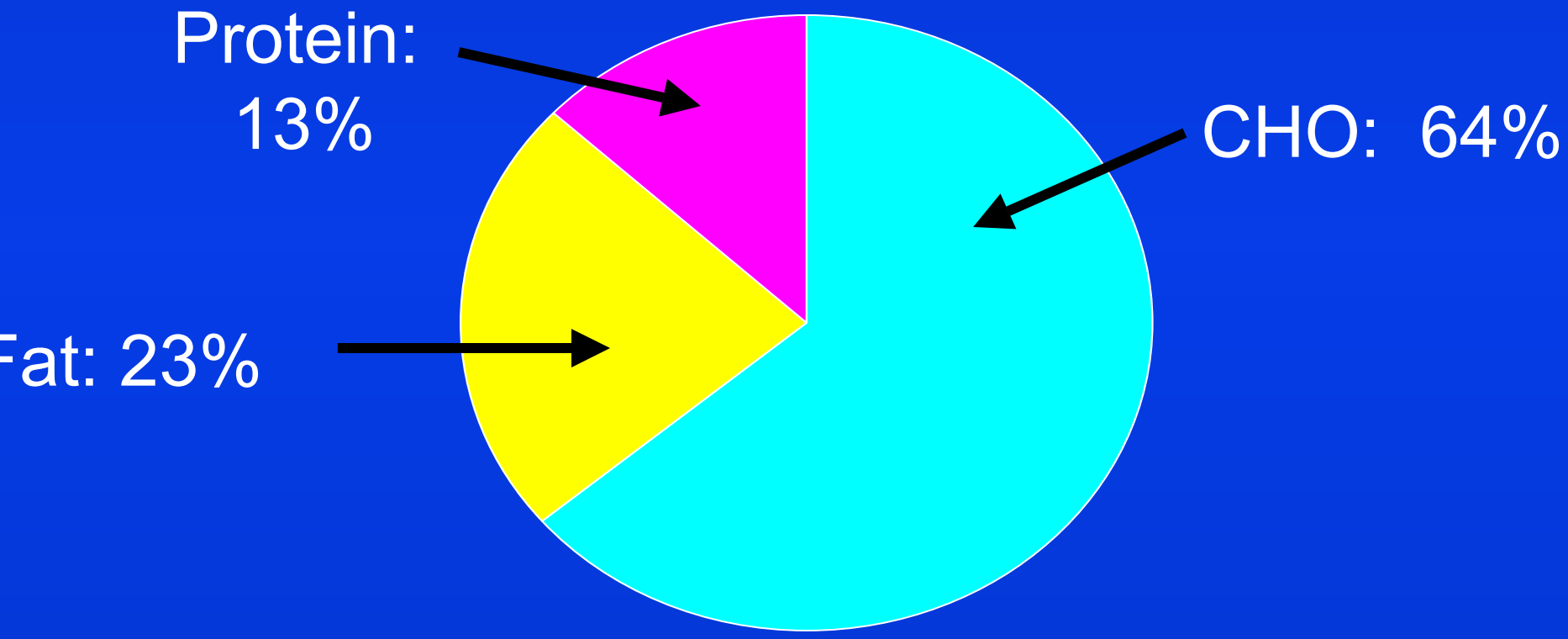
Planning for Vitamin B_{12}

- RDA for vitamin B_{12} for nonpregnant women
  31 - 50 y = 2.4 mg/day
- RDA for iron for pregnant women
  31 - 50 y = 2.6 mg/day
- No UL for vitamin B_{12}

Sample Vegan Menu for Client

- Breakfast: Oatmeal with raisins and almonds; fortified soy beverage; grapefruit juice
- Lunch: whole wheat pita w/garbanzo beans; pineapple-orange-banana juice; dried figs
- Dinner: Casserole - lentils, brown rice, broccoli; three-bean salad; tofu fruit pie; herbal tea
- Snack: English muffin with cashew butter; carrot sticks

Nutrient Analysis: Macronutrients and Energy



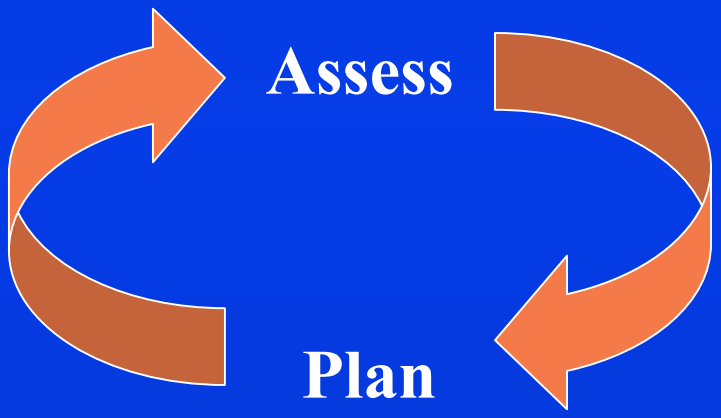
2,290 kcal, 46 g Fiber

Nutrient Analysis: Selected Vitamins and Minerals

Nutrient	Client Intake	RDA/AI
Vitamin B_{12}	3.1 μg**	2.4 μg
Vitamin D	1 μg**	5 μg
Vitamin E	24.6 mg	15 mg
Folate	795 μg DFE	400 μg DFE
Calcium	840 mg**	1000 mg
Iron	28.4 mg	27 mg (19 -49)#

** Fortified soy beverage was an important source

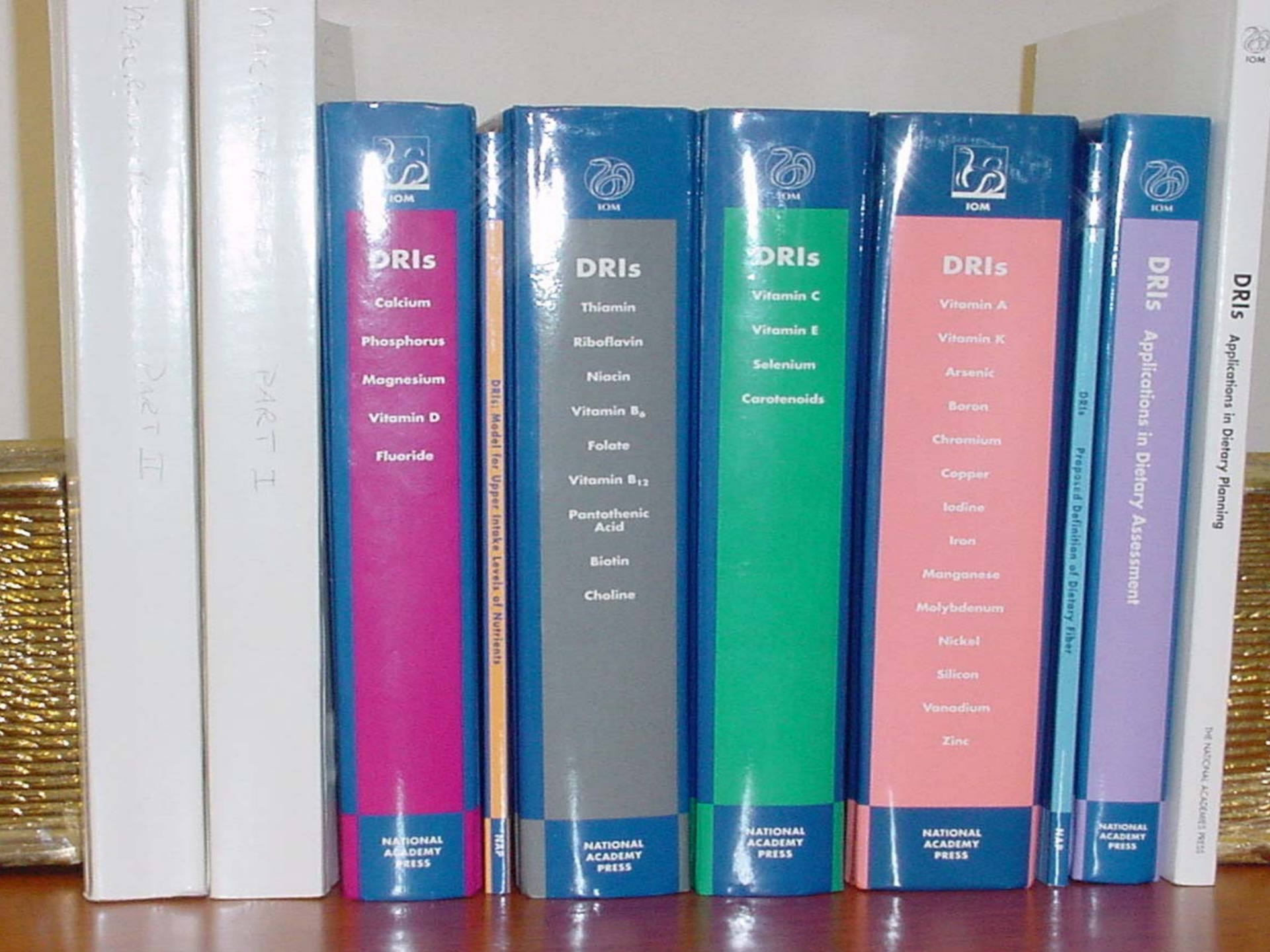
Assessing the Plan



- Energy: Monitor body weight over time
- Nutrients: To be confident intakes meet RDA/AI, need many days of records

In Conclusion

- Planning and assessing diets must be an interative process:
  1. Plan a diet using food guides.
  2. Check that the diet meets the EER, RDAs and AIs.
  3. Modify if necessary, and repeat.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DRIs: Model for Upper Intake Levels of Nutrients
NAP
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Riboflavin
Niacin
Vitamin B6
Folate
Vitamin B12
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Copper
Iodine
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Manganese
Molybdenum
Nickel
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